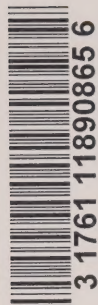


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A Study of the Relative Merits of Bulk and Individual Electrical Metering for Apartment Buildings in Ontario

prepared for
The Honorable James A. Taylor, QC
Minister of Energy
Ontario



Prepared by a Committee Representing
ONTARIO HYDRO
ONTARIO MUNICIPAL ELECTRIC ASSOCIATION
ASSOCIATION OF MUNICIPAL ELECTRICAL UTILITIES (OF ONTARIO)

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Minister of Energy
Province of Ontario

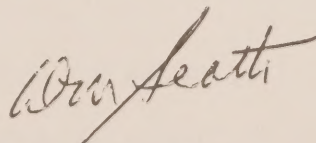
As agreed upon with your department we are delivering with this letter two copies of a report "A Study of the Relative Merits of Bulk and Individual Electrical Metering for Apartment Buildings in Ontario." This report was prepared by a Tri Party committee with representatives from Ontario Hydro, Ontario Municipal Electric Association, and Association of Municipal Electrical Utilities (of Ontario).

The Committee respectfully suggest to you that the recommendations in the report be implemented by means of an Ontario Hydro regulation established in accordance with Section 94 of the Power Corporation Act and enforced as part of the Ontario Electrical Safety Code by the Electrical Inspection Department of Ontario Hydro.

Confidential copies of this Report are being forwarded to the Presidents of the three participating organizations.

With your approval copies of this Report will be distributed to all Supply Authorities in Ontario.

Yours very truly,



D.M. Seath, P. Eng
Chairman

PREFACE

In June of 1976, the Select Committee reviewing Ontario Hydro's proposal to increase Bulk Power Rates tabled its report which included the following recommendations.

Ontario Hydro and the Municipal Utilities cease Bulk Metering Apartments and Townhouses and study the feasibility of retrofitting existing bulk metered buildings.

The Ontario Municipal Electric Association and the Association of Municipal Electrical Utilities (of Ontario) made a representation to the Minister of Energy on the recommendations and proposed undertaking a further in depth study including Ontario Hydro as a participant. The proposal was accepted by the Minister of Energy and the Committee was requested to report with recommendations to the Minister of Energy by the Fall of 1977.

This report describes the investigations, the studies undertaken and presents the Committee's recommendations.

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Power Service Department,
Toronto Hydro-Electric System

CONCLUSIONS AND RECOMMENDATIONS

MAJOR FINDINGS

An examination of electrical consumption patterns in apartment buildings revealed that residential customers whose service is provided through bulk meters tend to use more electrical energy than those who receive service through an individual meter. On a per suite basis, the actual annual energy difference amounted to 2,870 kilowatt hours and 657 kilowatt hours for all electric apartment buildings and gas heated apartment buildings, respectively. A benefit and cost analysis of the feasibility of abandoning bulk metering in new apartment suites indicated that such a move would yield significant conservation benefits, amounting to well over 6 billion kilowatt hours by the turn of the century. These savings are equivalent to supplying sufficient electrical power to about 30 per cent of the total 1976 residential service consumption in Ontario.

A move to individual metering for new apartment suites would mean an increase of approximately \$42 million in capital, operating and maintenance costs for the next 25 years. However, estimates of conservation benefits fall in the area of \$61 million of the same period, so that an aggregate benefit of at least \$19 million will be realized with such a move.

A benefit and cost analysis for the status of existing apartment buildings in Ontario revealed that a conversion to individual metering in most cases would be uneconomic.

METHODOLOGY

The difference in electrical consumption between the two types of metered buildings was determined through a variety of statistical techniques including multiple regression and analysis of variance. The final sample used in the analyses consisted of 48,632 suites located in 1,111 apartment buildings throughout Ontario. Data limitations restricted the examination of electrical consumption patterns to all electric and gas heated apartment buildings.

The merits of both bulk and individual metering were evaluated from the perspective of Ontario as a whole within a Benefit Cost framework. The analysis was primarily concerned with the examination of new multi-unit residential buildings in Ontario. However, consideration was also given to the status of existing multi-unit buildings.


Benefit and cost items were evaluated over a twenty-five year time horizon, between 1977 and 2001, inclusive. Where available data permitted it, these items were expressed in monetary units for every year covered by the analysis.

The data which served as the bases for future estimates of tangible benefit and cost categories were obtained through correspondence with various departments within Ontario Hydro, Municipal Utilities in Ontario, and electrical contractors.

RECOMMENDATIONS

On the basis of the findings of the study it is recommended that:

1. FOR ALL NEW MULTIPLE UNIT RESIDENTIAL BUILDINGS THE ELECTRICAL CONSUMPTION OF EACH SELF CONTAINED DWELLING UNIT SHALL BE INDIVIDUALLY METERED.
2. FOR ALL NEW MULTIPLE UNIT RESIDENTIAL BUILDINGS EMPLOYING POINT OF USE ELECTRIC HEATING, THE ELECTRIC HEATING SHALL BE UNDER THE CONTROL OF THE UNIT OCCUPANT AND INCLUDED IN THE METERED ELECTRICAL CONSUMPTION OF THE UNIT.
3. FOR ALL NEW MULTIPLE UNIT RESIDENTIAL BUILDINGS, ELECTRICAL EQUIPMENT WHICH IS UNDER THE CONTROL OF THE BUILDING OWNER SHALL BE BULK METERED.
4. IN EXISTING MULTIPLE UNIT RESIDENTIAL BUILDINGS WHICH ARE NOT METERED IN A MANNER WHICH CONFORMS TO THE PRACTICE RECOMMENDED HEREIN FOR NEW MULTIPLE UNIT RESIDENTIAL BUILDINGS, THE METHOD OF METERING MAY BE ALTERED TO CONFORM WITH THE RECOMMENDED PRACTICE BY MUTUAL AGREEMENT BETWEEN THE SUPPLY AUTHORITY AND THE BUILDING OWNER.
5. THE ABOVE RECOMMENDATIONS SHALL BE APPLICABLE TO ALL BUILDINGS WITH MORE THAN ONE SELF CONTAINED RESIDENTIAL DWELLING UNIT BUT WILL NOT BE APPLICABLE TO DWELLING UNITS USED FOR SHORT TERM OCCUPANCY SUCH AS THOSE IN HOTELS, MOTELS, ETC.



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INTRODUCTION

This report addresses the metering practice of electric service to residential customers who reside in multi-unit buildings in Ontario. Section I presents background information on this subject and discusses recent studies which have examined electrical consumption patterns in residential buildings with different types of metering practices. The extent of electrical consumption differences found between apartment buildings with bulk meters and those with individual meters in Ontario is reported in Section II. The section also describes the framework within which the merits of both bulk and individual metering are evaluated. The major findings of the investigation are discussed in Section III. Conclusions and recommendations are discussed in Section IV. Finally, a detailed description of data collection and processing for the conclusions presented is provided in the addendum.

SECTION I

1.0 BACKGROUND INFORMATION

The main function of a residential meter is to measure and record the kilowatt hours consumed at a customer's home. Prior to the 1960's, most electrical service to residences in Ontario was measured by means of a single or individual meter for each dwelling unit. In particular, it was common practice for most electric utilities in Ontario to provide each apartment dweller with a separate meter which serviced only that user.

During the 1960's, many electric utilities endorsed the use of a single or bulk meter to measure the electrical consumption of an entire multi-unit building, rather than separate meters for each unit. The growth of bulk metering continued throughout this decade and by mid-1976 over 80 per cent of the total number of apartment suites in Ontario were converted, or originally designed, to accommodate bulk meters.¹

The trend towards bulk metering which took place in Ontario during the last decade was also evident throughout the rest of Canada as well as in some parts of the United States. Bulk meters were common in apartment buildings in some parts of Canada by the late 1950's and in the United States by the early 50's.²

-
1. Power Market Analysis, Ontario Hydro.
 2. Although it is not clear just when or where the practice of bulk metering of residential space began in Canada, electric utilities in Quebec, British Columbia and Alberta confirmed that the concept was used in their jurisdiction prior to 1960.

Economic events during the early 1970's provided impetus to the installation of bulk meters in apartment buildings. In a period characterized with both double digit inflation and general economic recession, the practice of bulk metering offered a means by which apartment building owners could lower their capital costs while the electric distribution utilities could lower their capital and operating costs. In Ontario, these savings became even more pronounced as the province witnessed a fundamental shift to higher density accommodation from the mid-50's onwards.³ Multiple-unit construction, including apartments, semis and rows, accounted for only twenty per cent of housing starts in 1955. By 1970, however, the share of multiple-unit construction more than tripled to account for about 72 per cent of housing starts in Ontario. As a result of this development, many municipal utilities and apartment building owners favoured the bulk metering arrangement. In some cases, municipal utilities even encouraged conversion of existing individually metered apartment buildings to accommodate bulk meters.

However, in more recent years, there has been considerable interest and concern over the issue of energy conservation and a number of studies have attempted to examine energy saving possibilities. In particular, the practice of bulk metering of electric service to apartments has been identified as a potential source of energy conservation. To the extent that tenants with bulk meters tend to use appreciably more electricity than those

3. "Ontario Housing Requirements 1976-2001", a report presented to the Ministry of Housing, Peter Barnard Associates, (February, 1977).

with individual meters, it has been suggested that action should be taken to reverse the movement to bulk metering in the interest of conservation. A summary of recent studies which have examined electrical consumption levels in residential buildings with bulk and/or individual meters is presented below.

1.1 Energy Conservation Implications of Master Metering - Midwest Research Institute (August 1975)

Midwest Research Institute, an independent organization involved in energy and energy conservation studies, undertook a study for the US Federal Energy Administration to determine the differences in use of electricity in buildings with bulk and individual meters. The six-month study surveyed electricity consumption levels of over 4,000 dwelling units located in the ten largest metropolitan areas of the United States. It was found that, on average, residential customers in buildings with bulk meters consumed approximately 34 per cent more electricity than those with individual meters. On a per suite basis, the actual energy differences ranged from 240 kWh to as high as 4,756 kWh per annum.

The difference in electricity consumption between the two types of metered buildings was determined through an analysis of matched pairs of apartment buildings. These were chosen on the basis of:

- (a) geographic region;
- (b) size and number of dwelling units;
- (c) physical attributes of the building;

- (d) degree of and type of heating, ventilation, air-conditioning, water heating; and
- (e) occupant status.

While it was well recognized that a vast number of factors may influence the energy consumption by individual suites, the above-mentioned characteristics were assumed to be sufficient to distinguish pairs of matching apartments. Moreover, it was assumed that by matching pairs of apartments as closely as possible on the basis of these five factors, the difference in consumption per suite reflected differences in tenant use habits. In situations where energy consumption levels were compared over a period of time, a subjective test of weather effects on energy usage indicated that weather differences did not account for the higher energy use in bulk metered apartments.

A summary of the energy consumption differences for nine of the cities is shown in Table I.1. Adjusted average annual consumption levels per suite are shown under columns (2) and (4) for bulk and individually metered units, respectively, while the last column shows, on a percentage basis, the average ratio of consumptions for each of the cases listed.

It is interesting to note that in all situations examined, average consumption levels in bulk metered units exceeded those in individually metered units. However, the energy consumption differences varied considerably, ranging from 204 kWh per annum in a nine-unit building in Los Angeles to as high as 4,756 kWh per annum in two much larger buildings located in Kansas City, Missouri. The average ratio of consumptions was 134 per cent.

TABLE 1.1

RELATIVE ELECTRICITY CONSUMPTION OF
BULK METERED AND INDIVIDUALLY METERED
MULTI-FAMILY DWELLING UNITS

Metropolitan Area	<u>Bulk Metered Units</u>		<u>Individually Metered Units</u>		(5) Percent 2:4
	(1) No. of Units	(2) Annual Consumption Per Unit - kWh -	(3) No. of Units	(4) Annual Consumption Per Unit - kWh -	
Los Angeles	20*	3,456	20	1,284	269
	20*	1,968	20	984	200
	9*	2,868	9	2,664	108
Philadelphia	279	9,096	31 of 250	5,676	160
Detroit	44	2,904	44	1,748	166
	194	9,745	140	6,338	154
San Francisco	1,683*	3,105	1,683	2,298	135
Washington, DC	172 of 296	3,684	24 of 264	2,880	128
	76*	4,176	76	2,736	152
Boston	208	13,032	37	11,196	116
Pittsburg	216	17,316	92	13,368	130
	144	16,788	207	14,376	117
	21*	4,438	21	2,658	165
	20*	4,440	20	2,733	163
Kansas City	155	10,168	26 of 135	5,412	188
Houston	6*	15,000	6	13,678	110
	8	10,956	8	10,070	109
	60	14,124	6 of 60	12,444	114

* Metering service conversion

Source: "Energy Conservation Implications of Master Metering",
Midwest Research Institute, 1975.

The sample also included several apartment buildings which were converted to or from bulk metering. These cases are indicated by the asterisk under column (1) in Table 1.1. Again, it is interesting to note that while energy consumption levels differed after the building changed its form of metering practice, the net consumption differences varied considerably. For example, in the first case listed for the city of Los Angeles, consumption levels more than doubled after conversion from individual to bulk metering. At the same time, the third case listed for Los Angeles only showed an eight per cent increase after a similar conversion. In all conversion cases examined, consumption levels were higher for bulk metered apartments than for those with individually metered units.

1.2 Comparative Analysis of Electricity Consumption in Bulk and Individually-Metered Apartment Buildings - Power Market Analysis, Ontario Hydro (December, 1975).

A study was undertaken by Ontario Hydro in late 1975 to determine whether bulk metering in apartment buildings encouraged higher electricity consumption than individually metered buildings, and if so, by how much. The study examined electricity consumption levels of 2141 suites contained in 48 apartment buildings located in Hamilton and Metropolitan Toronto. Results of the study indicated that bulk metered apartments, as a group, used appreciably more electricity than those with individual meters. In fact, the average mean consumption of bulk metered suites was nearly 40 per cent higher than the comparable figure for individually metered apartments. On a per suite basis, the actual energy differences ranged from 791 kWh to as high as 1,939 kWh per annum.

The study was confined to an examination of fossil fuelled apartment buildings in Ontario. A representative sample of individually metered all electric apartment buildings could not be located in the study area at least in part because of mandatory bulk metering by-laws passed during the mid-60's. To ensure comparability between the two types of metered buildings the following energy uses were excluded:

- (a) central air conditioning;
- (b) electric saunas, swimming pool heater and incinerators;
- (c) electrically heated garages and/or ramp heaters; and
- (d) electric water heating in nonelectrically heated buildings.

This selection process virtually eliminated all luxury type apartments. Moreover, all condominiums, co-operatives and publically owned buildings were excluded due to possible consumption biases resulting from owner occupancy or rent subsidy. Finally, to further minimize questionable comparisons, mixed commercial-residential structures were excluded from the sample.

The final sample used in the study was comprised of 48 apartment buildings, all heated by gas or oil and evenly distributed between the two types of metering. These buildings accounted for 2141 apartment suites, 41 per cent of which were equipped with individual meters.

With the co-operation of the municipal utilities involved, average annual consumption levels were calculated for both bulk and individually metered dwelling units and subjected to an analysis of variance. In

individually metered apartments, unoccupied suites were excluded from analysis and the common energy consumption was prorated. All readings were based solely on 1974 consumption patterns.

A summary of major findings are shown in Table 1.2. Sample characteristics which were subjected to an analysis of variance are itemized under column (1) with the corresponding average annual consumption levels per suite shown under columns (2) and (3) for bulk and individually metered buildings, respectively. Columns (4) and (5) show the difference in consumption between the two types of buildings expressed in terms of both kWh's and percentage differences. The last column indicates whether this difference is statistically significant.

In all situations examined, average consumption levels in bulk metered suites exceeded those in individually metered suites. Moreover, with the exception of apartment buildings with less than 25 suites, the consumption differences were found to be statistically significant. These differences, however, varied considerably and ranged from 791 kWh per suite for buildings with less than 25 suites to as high as 1939 kWh per suite for buildings with more than 50 suites. On average, the mean consumption of bulk metered suites was 1443 kWh above the comparable figure for individually metered apartments in 1974. In terms of percentages, this figure represents a 39.5 difference in electrical energy consumption.

While it was well recognized that the sample should not be considered representative of all apartment buildings in Ontario, the study points out that in 1974 anywhere from 505 to 860 million kWh could have been saved if apartment buildings were individually metered.

TABLE 1.2

ANALYSIS OF VARIANCE ON BULK AND INDIVIDUALLY METERED
APARTMENT BUILDINGS

(1) <u>Characteristic</u>	<u>Annual Average Suite Consumption</u>		<u>Difference</u>		(6) <u>Significant</u> ²
	(2) - <u>Bulk</u>	(3) - <u>Individual</u>	(4) - <u>kWh</u>	(5) - <u>Percent</u> ¹	
Construction Year:					
(a) Before 1961	4899	3469	+1430	41.3	Yes-Very
(b) After 1960	5188	4016	+1172	29.2	Yes
(c) 1955-1966	5110	3767	+1343	35.7	Yes-Very
Size (Suites):					
(a) Under 25	4689	3898	+ 791	20.0	No
(b) 25-50	5338	3471	+1867	53.8	Yes-Very
(c) Over 50	5154	3215	+1939	60.3	Yes-Very
Distribution:					
(a) Smaller Suites	4553	3382	+1171	34.6	Yes
(b) Larger Suites	5486	4056	+1430	35.3	Yes
No Window Air Conditioning:	4663	3509	+1154	32.9	Yes
All Buildings:	5092	3649	+1443	39.5	Yes-Very

Notes:

1. Calculated by dividing the actual kWh difference as shown under column (4) by individual suite consumption as shown under column (3) and expressed on a percentage basis.
2. Based on the F-ratio test of significance.

Source: "Comparative Analysis of Electricity Consumption in Bulk and Individually Metered Apartment Building," Ontario Hydro, 1975.

1.3 Bulk Metering Versus Individual Metering of Apartment Buildings in
the Area Served by the Toronto Hydro - Toronto Hydro (July, 1976).

More recently, a study was undertaken by Toronto Hydro to evaluate the feasibility of converting existing bulk metered apartment buildings back to individual metering. Toronto Hydro, presently the largest municipal electrical utility in Ontario in terms of both sales and customers served, supplied nearly 500 bulk metered apartment buildings containing about 61,000 suites in 1975. While bulk metered apartments accounted for less than 20 per cent of the total number of apartment buildings served by Toronto Hydro, these buildings represented almost 60 per cent of apartment suites.

In order to determine the differences in energy usage between the two types of metering practice, a random sampling procedure was employed. Consumption levels of 33 fossil-fuelled buildings containing 2,707 suites were examined both before and after conversion from individual to bulk metering during the period from July 1972 to April 1975. To avoid any questionable comparisons, buildings which were completely or partially renovated over the testing period were eliminated from the sampling procedure. Moreover, annual consumption levels were adjusted for all suites to take into account natural load growth.

A summary of the consumption differences is presented in Table 1.3. Column (1) identifies each of the 33 apartment buildings included in the sample while column (20) shows the corresponding number of apartment suites. The average annual suite consumption levels for individually metered

TABLE 1.3

RELATIVE ELECTRICITY CONSUMPTION LEVELS OF
APARTMENT SUITES CONVERTED FROM INDIVIDUAL
TO BULK METERING

<u>(1)</u> <u>Case</u> <u>And Rank</u>	<u>(2)</u> <u>Number</u> <u>Of Suites</u>	<u>(3)</u> <u>Before</u> <u>Conversion</u> <u>- Average</u>	<u>(4)</u> <u>After</u> <u>Conversion</u> <u>Annual Suite</u>	<u>(5)</u> <u>Energy</u> <u>Difference</u> <u>Consumption</u>	<u>(6)</u> <u>Percent</u> <u>4:3</u> <u>- kWh -</u>
1	13	2094	3059	965	1.46
2	134	1864	2714	849	1.46
3	38	1802	2572	770	1.43
4	24	1978	2647	669	1.34
5	48	1861	2474	613	1.33
6	186	2505	3244	739	1.30
7	48	1917	2490	573	1.30
8	97	1919	2403	484	1.25
9	48	1839	2275	436	1.24
10	55	3279	4036	757	1.23
11	106	2819	3477	658	1.23
12	85	2121	2608	487	1.23
13	74	1959	2390	431	1.22
14	110	2817	3414	597	1.21
15	108	2384	2896	512	1.21
16	60	3125	3758	633	1.20
17	261	2035	2415	380	1.19
18	93	2230	2663	433	1.19
19	27	1286	1512	226	1.18
20	37	2123	2476	353	1.17
21	24	1593	1837	244	1.15
22	72	2392	2699	307	1.13
23	32	1916	2145	229	1.12
24	220	3446	3825	279	1.11
25	63	2272	2468	196	1.09
26	72	2568	2773	210	1.08
27	49	1372	1481	109	1.08
28	126	2025	2182	157	1.08
29	16	3135	3284	149	1.05
30	65	2086	2158	72	1.03
31	204	2032	2056	24	1.01
32	35	1578	1578	---	1.00
33	78	2600	2548	(56)	0.98

Note: 1. Bracket Indicates a Reduction in Electrical Consumption.

Source: "Bulk Metering Versus Individual Metering of Apartment Buildings in the Area Served by the Toronto Hydro," Toronto Hydro, 1976.

apartment suites are listed in column (3) of the same table. This set of consumption data represents the before conversion case. Similar data for the after conversion case - that is, consumption readings after conversion from individual to bulk metering - is shown in (4) while column (5) identifies the energy differences for each of the buildings listed in column (1). The last column shows, on a percentage basis, the average ratio of consumption for each of the cases listed.

As can be seen in Table 1.3, average consumption levels in bulk metered suites tended to be higher than comparable levels in individually metered suites. In fact, the survey indicated that, an average, apartment dwellers increased their electric energy consumption by nearly 20 per cent after the building was converted to bulk metering. The actual energy difference amounted to 430 kWh per suite per annum.

While average consumption levels increased following a conversion to bulk metering, energy differences varied considerably within the sample. Column (1) shows the ranking in descending order for each building examined in terms of the average ratio of consumption before and after conversion. The highest energy difference was found in a thirteen suite building. After conversion to bulk metering, average tenant consumption increased by 965 kilowatt hours per annum, or 46 per cent as shown in columns (5) and (6), respectively. In one situation, a seventy-eight suite building, the average consumption level actually decreased by 2 per cent following a conversion to bulk metering. This case is ranked last in column (1) of Table 1.3. In another situation, shown as case and rank number 32 in column (1), average consumption levels were the same both before and after conversion to bulk metering.

The study points out potential energy savings of slightly more than 26 million kilowatt hours per annum with a move to individual metering. At the same time, the study points out that such a move would lead to a significant increase in operating and capital expenditures, especially during the conversion process.

1.4 Report of the Board of Commissioners of Public Utilities of Newfoundland on Bulk Metering-Newfoundland Light and Power Company Limited - (March 1977).

In early 1977, Newfoundland Light and Power conducted an examination of bulk metering in its service area with particular emphasis on the probable revenue and cost consequences to the Company and its customers if it were discontinued. At the end of 1976, nearly one third of the apartment buildings served by Newfoundland Light and Power were bulk metered.

A comparison of energy consumption in two apartment buildings in Newfoundland under both bulk metering and individual metering situations showed relatively minor differences. Table 1.4 presents a summary of the major findings. Case A refers to a 38 suite all electric apartment building that was initially served through a bulk meter and then converted to individual metering. Under bulk metering, the average annual consumption for the entire building amounted to 664,300 kilowatt hours. Following a conversion to individual metering, the average annual consumption level was reduced to 602,034 kilowatt hours. Hence, the adjusted average annual kilowatt hour consumption under bulk metering was about 10 per cent higher than the average under individual metering. The actual energy difference amounted to 62,266 kilowatt hours.

TABLE 1.4

COMPARISON OF ANNUAL KILOWATT HOUR
CONSUMPTION LEVELS IN CONVERTED BUILDINGS

<u>Characteristics</u>	A	<u>Cases</u> B
1. Number of Suites	38	34
2. Initial Service	Bulk	Individual
3. Type of Building	All Electric	Oil Heated
4. Annual kWh Consumption*		
(a) Bulk	664,300	153,173
(b) Individual	602,034	149,180
5. Annual Energy Difference		
(a) kWh	62,266	3,993
(b) Percentage	10.3	2.7

* Adjusted for weather.

Source: "Report to the Board of Commissioners of Public
Utilities of Newfoundland on Bulk Metering,"
Newfoundland Light and Power Company Limited (March 19

Case B of the same table shows the consumption levels for a 34 suite oil heated apartment building that was initially served through individual meters and then converted to bulk metering. Under these circumstances, the average annual kilowatt hour consumption in the entire building increased by less than 3 per cent, or 3,993 kilowatt hours.

The study points out that even with a 35 per cent energy difference, the cost of Newfoundland Light and its customers of converting all existing bulk metered residential installations to individual would likely exceed the savings which might be experienced. Annual costs associated with such a move would amount to about \$130 thousand compared with annual benefits of only \$84 thousand.

1.5 SUMMARY

The results from these studies confirm that bulk metered apartments do use more electricity than those serviced with individual meters. Not suprisingly, the energy differences as reported in each study indicated considerable variation in these levels, particularly in Ontario. In recognition of these differences, the AMEU, representing municipal utilities in Ontario, set up a special committee which conducted a survey on this subject. Their results also indicated considerable variations and on presentation of this report to the Ministry of Energy it was agreed that further investigation was necessary.

It should be noted at this point that the percentages as reported by each study are not comparable in part at least because of the varying bases employed. For instance, the Mid-West Research Study reported that

energy differences averaged about 34.5 per cent while the Ontario Hydro study showed a 39.5 per cent difference. On the surface, it would appear that electrical energy differences are only slightly higher in the latter report than in the former report. A closer examination of the bases employed during the derivation of these percentages reveals that this may not be the case.

The percentages used in the Mid-West Research report compare domestic consumption levels between the two types of buildings while the Ontario Hydro study compares total consumption levels which includes the common service load in the buildings. Accordingly, these two approaches yield percentage differences that are not on a comparable bases and the reader should be cautioned when comparing percentage differences across the studies.

To minimize questionable comparison of electrical energy differences found in other reports, the findings from this study are expressed in absolute or physical quantities rather than on a percentage basis.

SECTION II

2.0 INTRODUCTION

This section of the report discusses the basic framework within which the merits of both bulk and individual metering are evaluated. The section also examines the extent of electric energy consumption differences found in Ontario between apartment buildings with bulk metered electric service and those with individual meters for each dwelling unit. In addition, the major assumptions made and the methods of data collection and processing are described. More detailed information is provided in the addendum.

2.1 SAMPLING METHOD

A survey of methodology was undertaken to determine the most effective means of investigating actual electrical energy use patterns in apartment buildings throughout Ontario, subject to certain resource and time constraints. While it would have been desirable to obtain socio-economic data on tenants covered by the survey itself, the above mentioned constraints would not allow it without major changes in scope. Nevertheless, it was felt that an attempt should be made to obtain socio-economic data on apartment dwellers by type of metering through external sources.

Questionnaire design allowed all information to be gathered through the owner and/or superintendent without contacting tenants. This process enabled the desired information to be obtained with reasonable degree of reliability and minimum time and effort. At the same time, sample design encouraged as many responses as feasible from all supply authorities throughout the Province.

In January of 1977, questionnaires along with instructions were forwarded to all municipal electric utilities in the province of Ontario and Ontario Hydro's Retail System. It was requested that they complete the forms with information attained, either by personal visit, mail or telephone. The responses to this phase of the sampling procedure yielded completed questionnaires from a total of 2,281 buildings containing 109,442 suites.

The information obtained from the questionnaires was compiled during the next phase of the sampling procedure and inspected. To avoid questionable comparisons, newly completed buildings as well as mixed commercial-residential complexes were excluded from further analysis. While the intention was to include comparisons for government assisted and condominium/cooperative apartments by type of metering, sufficient numbers of individually metered buildings could not be found in Ontario to allow meaningful analysis for these categories. Accordingly, all buildings that lacked individually metered counterparts were excluded from further investigation. Also, since the characteristics of oil space heated buildings were not considered compatible with anticipated apartment buildings, these were also eliminated from further analysis. The total effect of the above selection process reduced the sample by 653 apartment buildings.

Electrical energy consumption information for the remaining 1,628 apartment buildings was obtained from the utilities involved. Instructions and forms were forwarded to these utilities for completion from 1976 billing records. By the end of May, appropriate information had been received for 1,327 buildings. At this stage, some buildings were rechecked for accuracy of data before the sample was finalized. The final sample used for analysis consisted of 48,632 suites in 1,111 apartment buildings throughout Ontario.

The sample characteristics are summarized in Table 2.1. The upper portion of this table shows the distribution of apartment buildings by type of heating fuel and metering practice. Nearly 60 per cent of the sample consisted of natural gas heated buildings and of these, almost two thirds or 435 buildings were bulk metered. The rest of the sample was comprised of electrically heated buildings, including 273 with bulk meters and 175 with individual meters. The lower portion of Table 2.1 shows the distribution of apartment suites by type of heating fuel and metering practice. As can be seen, most of the apartment suites included in the sample were bulk metered and heated by natural gas. These suites alone accounted for about 63 per cent of the 48,632 apartment suites in the sample.

Several additional points are noteworthy in regard to the structure of the study sample. In particular, it is evident that from a statistical point of view, the sample is more than satisfactory both in terms of buildings and apartment suites surveyed. About 9 per cent of all apartment suites situated in Ontario were included in the sample.⁴ Moreover,

4. There are presently about 550,000 suites situated in apartment buildings (six or more suites) in Ontario.

TABLE 2.1

SAMPLE CHARACTERISTICS

(1) Apartment Building Distribution

	<u>Bulk Metered</u>	<u>Individually Metered</u>	<u>Row Totals</u>
Natural Gas Heated	435	228	663
All Electric	273	175	448
Column Totals	708	403	1,111
		Grand Total:	<u>1,111</u>

(2) Suite Distribution

	<u>Bulk Metered</u>	<u>Individually Metered</u>	<u>Row Totals</u>
Natural Gas Heated	30,608	7,771	38,379
All Electric	8,141	2,112	10,253
Column Totals	38,749	9,883	48,632
		Grand Total:	<u>48,632</u>

the present sample is significantly larger than any of those used in other related studies. In fact, compared with the Mid-West Research study carried out in the United States, the sample used in this report is well over ten times larger in terms of apartment suites surveyed. The sample also includes apartment buildings from all regions in Ontario.

2.2 STATISTICAL DISCUSSION

The purpose of this subsection of the study is to determine the extent to which significant consumption differences exist between bulk and individually metered apartments within the sample, as previously defined. Questionnaire design and return allowed a variety of techniques to be used in determining possible consumption differences; namely,

1. Multiple regression on 663 natural gas heated buildings;
2. Multiple regression on 448 electrically heated buildings;
3. Analysis of variance on 299 matched natural gas heated buildings;
4. Analysis of variance on 379 matched electrically heated buildings, and
5. Consumption comparisons for 34 natural gas heated buildings converted from bulk to individual metering.

Prior to subjecting the data to any of the above mentioned techniques, electrical consumption levels in electrically heated apartments were adjusted to take into account degree day differences within the sample. One-half of the total consumption was attributed to space heating in each apartment building. This was weather corrected using degree day averages by regions, with Metro Toronto serving as the base. Since the consumption data applied to a given point in time (the year 1976) further adjustment to the raw data was unnecessary.

It was felt that in a study such as this the technique using the largest number of observations would be the most appropriate. While the multiple regression technique provided this vehicle, it was felt that other statistical techniques should also be applied as additional support. Accordingly, the techniques employed for determining the energy differences to be used in later stages of the main study is multiple regression. Analysis of variance and conversion results were found to be corroborative and are discussed at more length in their respective addenda.

In multiple regression the analyst is concerned with identifying and measuring the relationship between variables. The relationship is expressed in mathematical form by determining an equation connecting the variables. In effect, the equation hypothesizes how one of the variables, called the dependent variable, is affected by a change in the value of other variables, referred to as independent variables. Once the nature of the relationship is estimated, tests can then be conducted to determine whether the independent variables have a significant effect on the dependent variable and by how much.

In the context of the present report, the first step was to control for all available characteristics which could affect annual suite consumption by heating type; namely, age of building, number of suites, swimming pool, sauna, ventilation system, suite distribution by size, and so on. The resultant set of equations, however, indicated that certain of the characteristics were insignificant to consumption because of cross-correlation with other characteristics while others had very little or no effect on consumption. The next step was to control for those characteristics which were significant to consumption and at the same time introduce the variable "Bulk" to the regression equation. The coefficient of the "Bulk" variable was interpreted as the amount of kilowatt hour consumption attributable to bulk metering.

The major findings are summarized in Table 2.2. The results indicated that the amount of suite consumption attributable to bulk metering was in the order of 657 kilowatt hours and 2,870 kilowatt hours for apartment buildings heated by natural gas and electricity, respectively.

Comparable figures through an analysis of variance using the matched sub-samples produced annual suite consumption differences of 536 kilowatt hours and 2,690 kilowatt hours for the same apartment building classification. Furthermore, the sample of natural gas heating buildings converted to bulk metering showed an annual consumption difference of 676 kilowatt hours per suite.

TABLE 2.2

SUMMARY OF MULTIPLE REGRESSION RESULTS

	(1) <u>Natural Gas</u>	(2) <u>All Electric</u>
(1) Number of Buildings	663	448
(2) Control Variables	(a) Sauna (b) Swimming Pool (c) Electric Ramp/Heaters (d) Air Conditioning (e) No. of Suites	(a) Electric Ramp/Heaters
(3) Mean Suite Consumption	4,802 kWh	14,559 kWh
(4) Annual Suite Con- sumption Attributed to Bulk Metering	<u>657 kWh</u>	<u>2,870 kWh</u>

It was well recognized, however, that other factors such as saturation of small appliances within the suites, life-cycle distribution of tenants and average annual income may have affected suite consumption levels within the sub-samples. Through external sources, comparisons were made between bulk and individually metered apartments in Ontario to determine whether significant differences existed for these variables.

The Energy Application Survey for 1976 as carried out by Ontario Hydro indicated no significant differences in small appliance saturation by type of metering. Similarly, the life-cycle distribution of tenants in a file produced jointly by Ontario Hydro and Statistics Canada showed no significant differences by type of metering. The same file did, however, indicate that bulk metered apartment dwellers earned slightly higher incomes than their individually metered counterparts. To the extent, if any, that the relationship between income and electricity consumption is positive then some portion of the consumption differences between bulk and individually metered apartment buildings could be attributed to differences in income.

2.3 FRAMEWORK OF THE ANALYSIS

The basic perspective brought to bear throughout this report involves an evaluation of the merits of both bulk and individual metering for the overall economic welfare of Ontario citizens. The objective here is to determine whether the province will be better off in a material sense with the adoption of individual metering. In particular, the policy options under consideration include:

. BULK POLICY OPTION - the requirement of a single, bulk meter to measure and record the electrical consumption in new multi-unit buildings.

. INDIVIDUAL POLICY OPTION the requirement of a separate, individual meter to measure and record the electrical consumption for each suite in new multiple unit buildings.

It should be noted that the analysis is primarily concerned with the examination of new multi-unit buildings in Ontario. A preliminary investigation into the status of existing structures revealed that a number of serious drawbacks would be encountered in retrofitting these structures to accommodate a different type of metering practice. In particular, it was found that conversion costs in some cases could easily amount to thousands of dollars on a per suite basis, depending on the characteristics of the building in question. At the same time, it was found that conversion costs in other cases might be considerably less, especially in those buildings presently serviced with bulk meters but originally designed to accommodate individual meters. In most cases, however, cost estimates were found to be either highly uncertain or subject to a great deal of variation. To avoid questionable comparisons, the subject of conversion is treated in isolation and discussed in Section III of the report.

The major concern of this study, then, is to compare the benefits and costs associated with the two policy options in order to determine the overall net benefit or cost to Ontario as a whole. Moreover, the analysis is

primarily concerned with the benefits and costs in terms of actual physical resources employed in each policy option. For reasons of convenience, all measurements are ultimately expressed in present day dollars.

It is well recognized, however, that the evaluation of certain types of benefits and costs is often extremely difficult. Included in this category are those benefits and costs which are not usually priced in the market place, but which are nevertheless incurred by society. For instance, there are psychic benefits associated with individual metering in the sense that the apartment dweller "pays for what he gets" and does not have to be concerned about subsidizing another's consumption. At the same time, there are psychic benefits associated with bulk metering. For example, apartment dwellers in a bulk metered building who tend to use more electricity will suffer a loss of benefit in moving to individual metering. This difference in consumption does have some value to the customer over and above what is paid in his monthly rent.

In most situations, these types of benefits and costs can be readily identified. The difficulty arises in evaluating them on a comparable basis, particular in terms of monetary units. Unfortunately, many of these problems of valuation can only be resolved by judgemental decisions, without an explicit dollar measurement.

Since many of these considerations are evident in this particular study, benefits and costs associated with both policy options under analysis are dealt with under the following broad categories and treated in isolation:

- . TANGIBLES - comprised of those benefit and cost items which are priced in the market place.

- . INTANGIBLES - comprised of those benefit and cost items which are not usually priced in the market place, but are nevertheless incurred by society either directly or indirectly.

The tangible benefits associated with individual metering include:

- . ENERGY BENEFITS: which consist of the fuel and variable operation and maintenance expenses incurred by the generating authority that provides energy; and

- . CAPACITY BENEFITS: associated with building and maintaining a system with sufficient capacity to meet all electrical demands place on it.

To attain these tangible benefits, additional goods and services must be used in the process. The expenditures made for these goods and services are defined as the tangible costs associated with individual metering. These include:

- . INSTALLATION COSTS: which consist of the labour and material expenses of installing additional meters;

- . CONTRACTING COSTS: which consist of the labour and material expenses incurred by the contractor to accommodate additional meters; and
- . OPERATION, MAINTENANCE AND ADMINISTRATION COSTS: associated with reading, billing and collecting additional customer accounts plus testing and recalibrating additional meters.

As previously mentioned, there are recognizable benefits and costs associated with individual metering for which it is either extremely difficult or virtually impossible to evaluate in monetary terms. Denoted as intangibles, these include:

- . CONSERVATION BENEFITS: associated with the value of redistributing current electrical consumption to future consumption;
- . EXTERNAL BENEFITS: which consist of the value attributable to the reduction in environmental costs associated with the production of electricity.
- . CONSUMERS' SURPLUS COSTS: associated with the value of the energy difference to the consumer which is lost in moving to individual metering; and
- . OTHER BENEFITS AND/OR COSTS: which may be associated with a given metering practice.

It is important to note that consequences which alter the distribution of total income without affecting its volume, are not evaluated in this report. For instance, the prevailing rate structure for utility service enables the bulk metered customer to purchase the same amount of electricity as would be consumed by the tenants at a lower price by acting as a single customer. Hence, in the short term, a move to individual metering may result in an increase in total revenue to the utility. From a global point of view, however, the change in total revenue may be viewed as a distributional effect in the sense that a utility's gain is exactly offset by the individually metered customer's loss. Moreover, the excess revenue is eventually passed on to its customers. Accordingly, the net effect merely results in some customers being made better off by making others correspondingly worse off.

This is not to say that such distributional effects are unimportant or irrelevant in considering the merits of the metering options. However, it is felt that such considerations are beyond the scope of this report.

A variety of considerations influenced the selection of an appropriate time period for the analysis. In particular, it was felt that the time period should be long enough to adequately measure and evaluate the benefits and costs associated with both policy options. At the same time, however, it was felt that too long a period would tend to make estimated benefit and cost differences meaningless because of possible forecasting uncertainties. The discount rate used to compare future streams of benefits and costs at a common point in time also influenced the selection of the time period. The higher the discount rate, the less significant the future dollar transactions in terms of discounted benefit and cost streams.

Given these considerations, the benefits and costs derived from both policy options are evaluated over a twenty five year time horizon, between 1977 and 2001, inclusive. The selected period is sufficiently long to evaluate all relevant benefits and costs with a reasonable degree of forecasting accuracy.

Benefit and cost items are expressed in monetary units for every year covered by the analysis. However, the worth of a dollar today is generally different from that of a dollar in the future. Accordingly, all estimates of future expenditures are converted to equivalent values at a common point in time by means of a discount rate. The use of a discount rate in this report is intended then to reflect the time value of money.

It is important to note at this point that all future dollars are also adjusted to reflect anticipated levels of wages and prices in the economy. Hence, all estimated cash flows occurring beyond 1977 are evaluated in nominal, as opposed to real or constant dollars. Since the analysis is concerned with the impact a given policy option will have on total real output or consumption in the provincial economy, a nominal discount rate is utilized to account for general inflation or deflation in the overall price level. To provide a measure of the sensitivity of the final results to the nominal discount rate, several values ranging from 10% to 25%, are employed.

2.4 METHOD OF DATA COLLECTION

The data which served as the bases for future estimates of tangible benefit and cost categories was obtained from various departments within Ontario Hydro, Municipal Utilities in Ontario, and electrical contractors. Since one of the primary objectives of the report was to measure how total expenditures in Ontario would be affected by the type of metering practice employed, it was felt that initial dollar estimates should reflect incremental expenditures rather than average expenditures. While this approach yielded satisfactory results for most tangible categories, the acute lack of data in some cost categories necessitated the use of average cost figures. However, there was little or no reason to believe that the average figures for these items would differ appreciably from incremental estimates. A detailed description of all the benefit and cost categories is left for the addendum.

The analysis in this report is confined to an examination of the metering practice of self contained dwelling units located in a separate structure of six units or more and originally designed as an apartment building. This definition includes condominiums but excludes other multiple dwellings such as row housing, townhouses and structurally converted houses and flats, ranging in size from two up to and including five self contained dwelling units. An estimate for the total number of apartment buildings as well as the total number of corresponding suites situated in Ontario was calculated for every year covered by the analysis. The bases upon which these forecasts were derived are discussed at some length in the addendum.

2.5 ASSUMPTIONS

For the purpose of this report, it was necessary to incorporate a number of qualifying assumptions which have a direct bearing on the analysis and the conclusions presented. These are discussed below while other, more specific assumptions are addressed in the context in which they arise.

In this study, it is assumed that all productive resources in the provincial economy are fully employed throughout the time period covered by the analysis. The full employment assumption permits the use of market prices to reflect the value of all goods and services required for a given policy option. This assumption also has the effect of eliminating secondary, or multiplier effects from the analysis.

Secondary effects refer to benefits and costs that are induced by the policy option under consideration. For instance, a move to individual metering creates employment opportunities in the manufacturing sector of the economy as the result of the increase in demand for individual meters. From a provincial point of view, employment benefits can be associated with individual metering.

However, in a fully employed economy, it is reasonable to expect that similar employment opportunities would have been created had resources been put to use in an alternative activity. Moreover, it is reasonable to assume that all secondary benefits and costs generated by a given policy option would have the same or equivalent value of secondary

effects induced by alternative activities. Accordingly, secondary benefits and costs which may be associated with either bulk or individual metering are not evaluated in this report.

As previously noted, benefit and cost categories are evaluated over a twenty-five year time horizon and, in the case of tangible items, ultimately expressed in monetary units for every year covered by the analysis. Moreover, all future dollar estimates are adjusted to reflect anticipated levels of wages and prices in the economy.

Ideally, future estimates should take into account all future conditions and actions such as changes in engineering design, material shortages, improvement in work methods, new constraints based on shifts in public concern, and so on. Future conditions, of course, are often extremely difficult to ascertain, particularly in terms of technological developments. While an attempt was made to adjust market prices to reflect the anticipated general economic climate, no attempt was made to evaluate the consequences of major technological advances. All estimates then are based on the existing state of technology in terms of metering practices.

SECTION III

3.0 INTRODUCTION

The final benefit/cost results along with a description of the base data are presented in this section of the report. In addition, this section includes the details of all calculations presented and related assumptions used throughout the analyses.

As discussed in the previous section, benefit and cost items are classified into two main categories and treated in isolation. Tangible items are ultimately expressed in monetary units and subjected to sensitivity analysis. Intangible benefits and costs, on the otherhand, are merely identified and for the most part discussed in general terms. In a few cases, however, explicit dollar measurements are provided to give some indication of their "real" values. Admittedly, the intangible items expressed in monetary units are crude approximations only and the reader should be cautioned against attaching undue confidence to these explicit dollar measurements.

All estimates presented here are based on a 15 percent nominal discount rate and, for comparative purposes, measured in 1977 present value dollars. For exposition purposes, the final results are presented from the individual metering point of view. In otherwords, it is assumed that all new apartment buildings in Ontario over the next 25 years are individually metered. Both benefits and costs associated with bulk metering are subtracted from those of individual metering to arrive at net or incremental benefits and costs.

3.1 TANGIBLE BENEFITS

As discussed in the previous section, an examination of electrical consumption patterns in apartment buildings revealed that residential customers whose service is provided through bulk meters tend to use significantly more electrical energy than those who receive service through an individual meter. In particular, it was shown that on a per suite basis the actual annual energy difference amounted to 2,870 kilowatt hours and 657 kilowatt hours for all electric apartment buildings and gas heated apartment buildings, respectively. Insofar as these energy differences continue to remain at their respective levels over the next 25 years, a move to individual metering would yield electrical energy savings in these types of buildings.

To determine the extent of these savings, however, it is necessary to estimate both the number of new apartment suites and the corresponding number of apartment buildings in Ontario up to, and including, the year 2001. This information also serves as the basis upon which all other benefit and cost components are derived. A detailed description of the apartment building data is provided in the addendum.

Table 3.1 summarizes the electrical consumption savings associated with individual metering. All entries are expressed in physical units; that is, millions of kilowatt hours. Column (1) of this table shows the level of total electrical energy savings for each year of the study period. While, on average, these savings amount to almost 270 million kilowatt hours per annum over the next twenty-five years, the actual savings realized are

TABLE 3.1

ELECTRICAL CONSUMPTION SAVINGS ASSOCIATED
WITH INDIVIDUAL METERING

<u>Year</u>	(1)	(2)
	<u>Annual Incremental Consumption</u>	<u>Cumulative Incremental Consumption</u>
	- MILLION kWh -	
1977	14.0	14.0
1978	42.0	56.0
1979	69.8	125.9
1980	98.5	224.4
1981	128.2	352.6
1982	155.2	507.7
1983	177.9	685.7
1984	195.9	881.6
1985	211.0	1,092.6
1986	225.3	1,317.9
1987	238.8	1,556.7
1988	252.4	1,809.0
1989	266.3	2,075.3
1990	282.7	2,358.0
1991	303.3	2,661.3
1992	325.8	2,987.1
1993	344.9	3,332.0
1994	361.4	3,693.3
1995	378.7	4,072.0
1996	396.4	4,468.4
1997	415.7	4,884.1
1998	434.4	5,314.5
1999	452.9	5,771.5
2000	471.6	6,243.1
2001	494.5	6,737.6

NOTE: 1. Detail May Not Add Due To Rounding.

relatively small in the short term. In the first year, 1977, electrical energy savings only amount to 14 million kilowatt-hours and it is not until 1981, when the 100 million figure is reached. By the end of the study period, annual savings total nearly 500 million kilowatt hours.

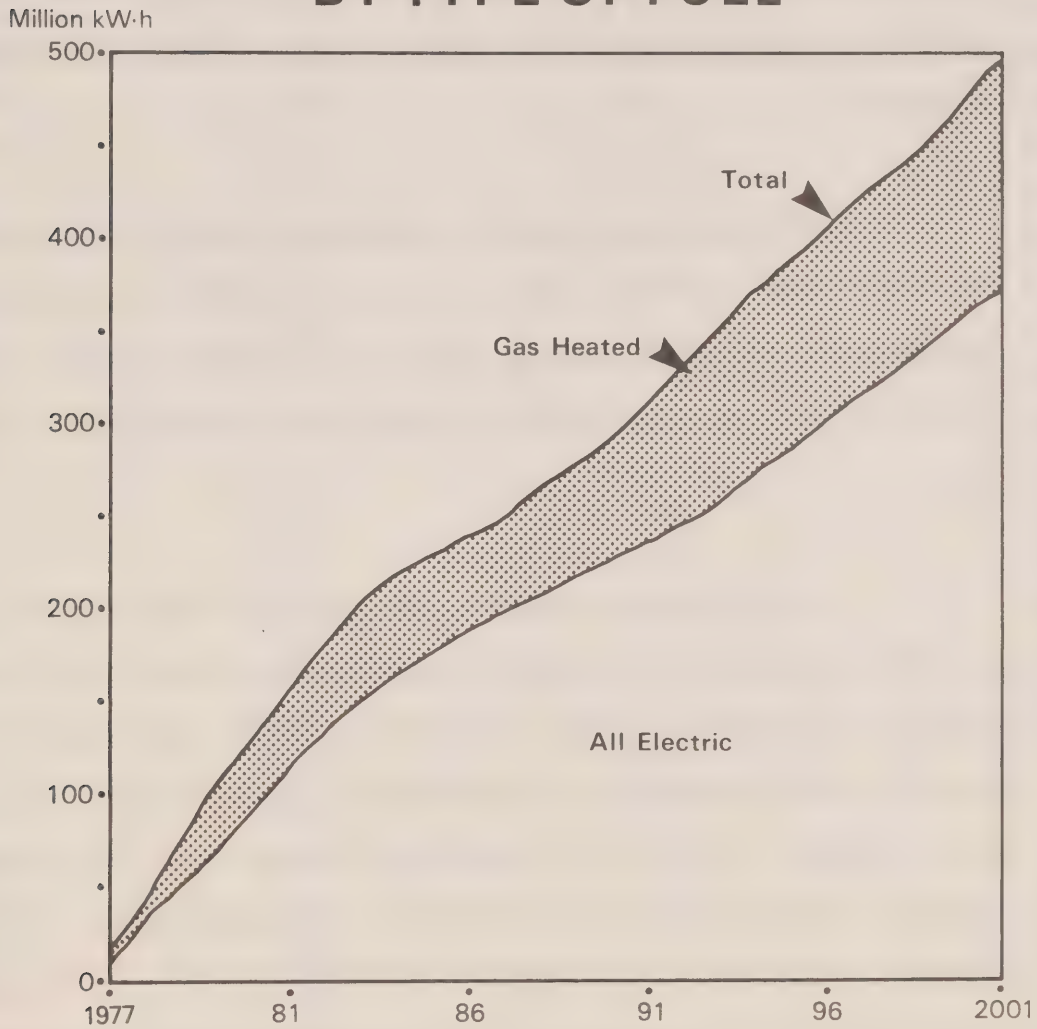
The total amount of electrical energy accrued at any given year during the period of analysis is shown under column (2) of Table 3.1. As can be seen, total energy savings double in each of the years prior to 1980. By the mid-1980's, total energy savings pass the one billion kilowatt hour mark and by the turn of the century, accumulate to well over 6 billion kilowatt hours. This amount is equivalent to supplying sufficient electrical power to about 30 percent of the total 1976 residential service consumption in Ontario.⁵

The distribution of annual electrical energy savings by type of fuel is illustrated in Figure 3.1. This distribution is based on the assumption that about 50 percent of all new apartment buildings constructed in Ontario over the next 25 years are gas heated while 35 percent are all electric. The remaining 15 percent are assumed to be oil heated.

Despite the relatively high penetration rate of gas heated apartment buildings anticipated throughout the forecast period, these buildings account for less than 25 percent of the total electrical energy savings in any given year. The energy savings associated with all electric apartment buildings are by far more significant and account for the remaining 75 percent.

5 . Ontario Hydro Statistical Yearbook, Ontario Hydro (1977).

FIGURE 3.1
DISTRIBUTION OF ANNUAL
ELECTRICAL ENERGY SAVINGS
BY TYPE OF FUEL



These physical energy savings are translated into two distinct benefit streams, reflecting the costs associated with producing more electricity which are reduced in moving to individual metering. Firstly, there are energy benefits which consist of the fuel and variable operation and maintenance expenses incurred by the generating system that provides energy. Secondly, there are capacity benefits associated with building and maintaining a system with sufficient capacity to meet all electrical demands placed on it.

The present dollar worth of energy and capacity benefits over the next 25 years is shown in Table 3.2. Column (1) identifies the energy benefits while column (2) shows the extent of the capacity benefits. The last column in the same table shows the total tangible benefits for any given year.

As can be seen in Table. 3.2, total tangible benefits amount to about \$60.7 million for the period of analysis. Moreover, these benefits are fairly evenly distributed in terms of energy and capacity. Both average about \$1.2 million per annum. As illustrated in Figure 3.2, capacity benefits initially appear to be far more significant in dollar terms than energy benefits, accounting for over 90 percent of the total benefits in 1977. However, as the stock of new apartment buildings grows over time, energy benefits become more pronounced. By the mid-80's, the energy component accounts for over 50 percent of the annual total benefits and in the final year of analysis, well over 90 percent. Total benefits average about \$2.4 million over the 25 year period.

TABLE 3.2

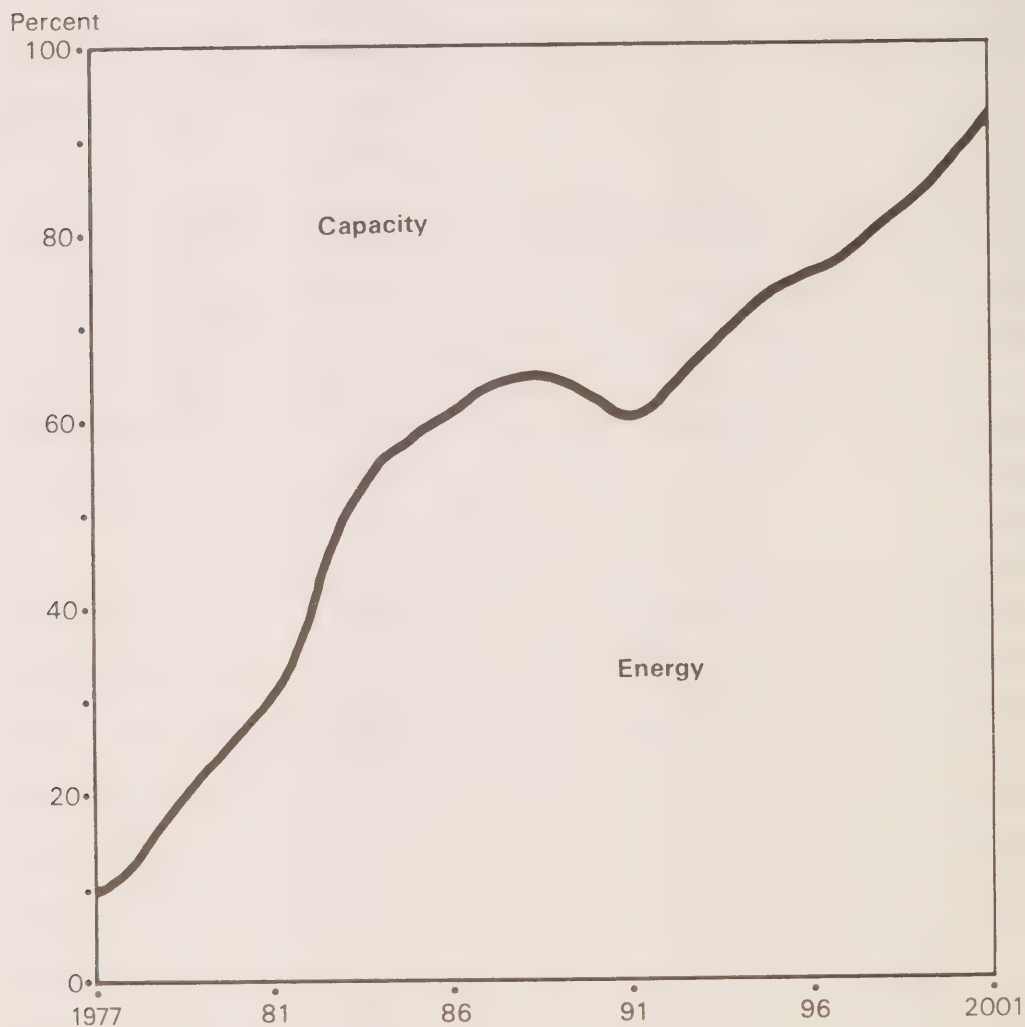
PRESENT WORTH OF TANGIBLE BENEFITS FOR INDIVIDUAL METERING
IN YEAR SHOWN
1977 \$'THOUSANDS

<u>Year</u>	(1) <u>Energy</u>	(2) <u>Capacity</u>	(3) <u>Total Benefits</u>
1977	171	1,614	1,785
1978	501	3,139	3,641
1979	753	3,027	3,780
1980	947	3,041	3,988
1981	1,197	3,042	4,239
1982	1,306	2,688	3,995
1983	1,503	2,177	3,679
1984	1,860	1,660	3,521
1985	1,706	1,347	3,052
1986	1,668	1,159	2,827
1987	1,611	973	2,585
1988	1,554	884	2,438
1989	1,495	806	2,301
1990	1,450	843	2,293
1991	1,391	927	2,318
1992	1,348	886	2,234
1993	1,283	654	1,936
1994	1,207	484	1,691
1995	1,138	427	1,565
1996	1,068	361	1,429
1997	1,913	317	1,329
1998	954	238	1,192
1999	895	171	1,066
2000	833	111	945
2001	795	65	860
TOTAL	29,648	31,041	60,689

Note:

1. Detail may not add due to rounding.

FIGURE 3.2
BENEFIT CATEGORIES AS A PERCENT
OF TOTAL BENEFITS



3.2 TANGIBLE COSTS

On the cost side, there are additional goods and services that must be used to gain the benefits that have been described. A move to individual metering means that higher capital and operating expenses must be incurred over the next 25 years. Additional meters must be installed in all new apartment buildings and additional wiring must be introduced to accommodate these meters. At the same time, a move to individual metering means higher annual reading, billing and collecting costs because of the increased number of customer accounts.

A summary of the tangible costs associated with individual metering is shown in Table 3.3. Three cost categories are identified: operation, maintenance and administration (OMA); installation; and contracting. The first cost category, OMA, consists of the additional expenses incurred in reading, billing and collecting customer accounts on a year by year basis as well as the periodical costs associated with testing and recalibrating individual meters. As can be seen under column (1) of Table 3.3, these expenditures amount to slightly over \$13.2 million over the study period and average about \$.5 million per year.

The actual cost of the additional meters plus the labour expenses associated with installing these meters are grouped under the second cost category and shown under column (2) of the same table. The total cost of installation is in excess of \$10 million over the study period and averages less than \$.5 million per annum for the next 25 years. The final cost category, contracting, is shown under column (3) and is intended to reflect the value of

TABLE 3.3
PRESENT WORTH OF TANGIBLE COSTS¹ FOR INDIVIDUAL
METERING IN YEAR SHOWN¹
1977 \$'THOUSANDS

	(1)	(2)	(3)	(4)
<u>Year</u>	<u>OMA</u> ²	<u>Installation</u>	<u>Contracting</u>	<u>Total Cost</u>
1977	100	1,373	2,354	3,726
1978	219	1,246	2,176	3,641
1979	330	1,138	2,034	3,502
1980	433	1,109	1,990	3,532
1981	527	993	1,804	3,324
1982	589	764	1,433	2,786
1983	623	558	1,072	2,253
1984	647	369	728	1,745
1985	646	322	633	1,601
1986	648	279	558	1,485
1987	632	232	465	1,330
1988	630	231	461	1,321
1989	610	202	406	1,218
1990	612	230	462	1,303
1991	602	229	467	1,298
1992	607	196	402	1,205
1993	593	133	275	1,001
1994	580	113	234	926
1995	564	94	196	853
1996	548	83	175	807
1997	533	67	141	742
1998	520	48	103	672
1999	501	33	72	606
2000	487	18	42	548
2001	465	4	12	480
TOTAL	13,247	10,065	18,693	42,005

Notes:

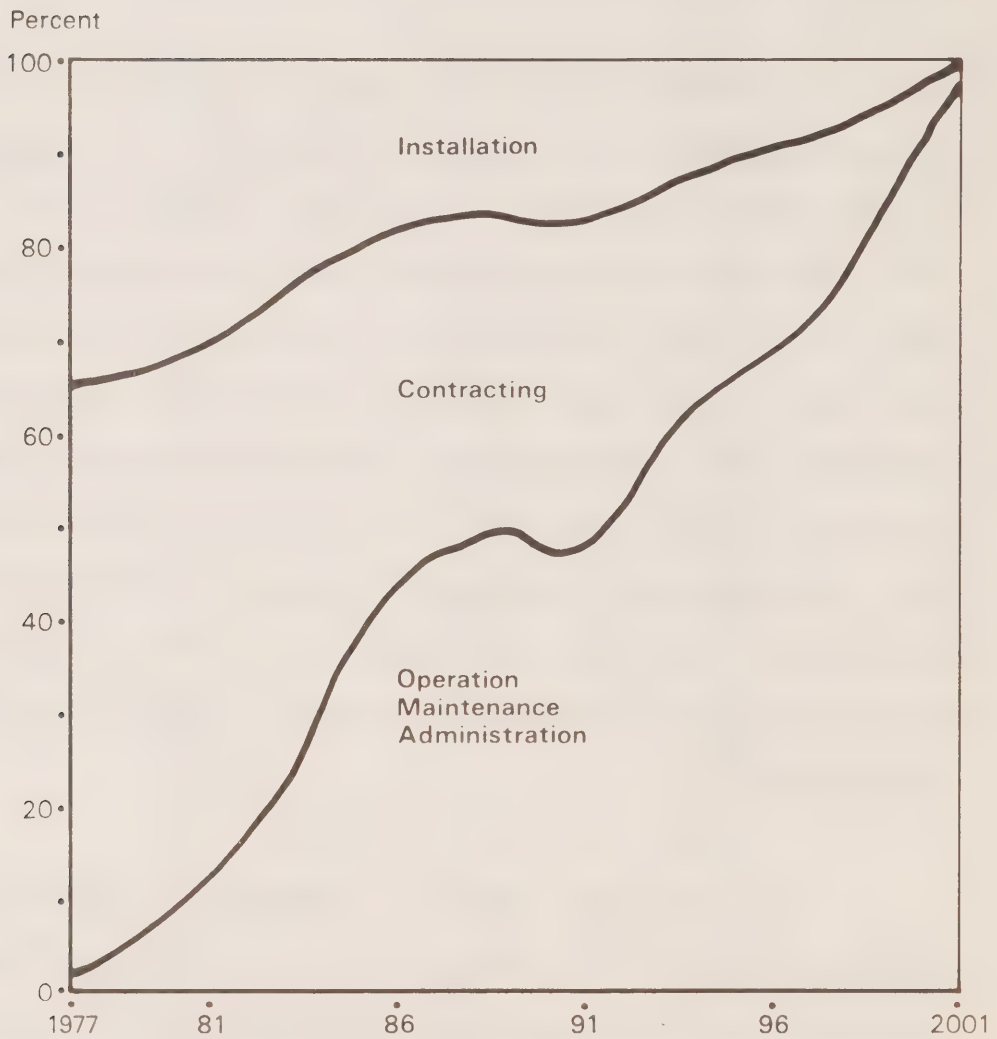
1. Detail may not add due to rounding.
2. Operation, maintenance and administration costs.

additional wiring, closet space, and so on, needed to accommodate the individual meters. In total, contracting costs amount to nearly \$18.7 million and average about \$.8 million annually. The total cost associated with individual metering is shown on a year by year basis in the last column of Table 3.3. At the turn of the century, tangible costs accumulate to about \$42 million or \$1.7 million per annum over the next 25 years.

The proportion of each cost category to total costs in any given year is illustrated on a percentage basis by Figure 3.3. It is interesting to note that while contracting costs account for about 60 percent of total costs in the early years, its relative share diminishes appreciably over the years and by the final study year accounts for less than 3 percent of the total annual cost. On the other hand, the costs associated with operation, maintenance and administration are a relatively small proportion of total costs during the early years but turn out to be the most significant in later years. In the final study year, this cost category accounts for nearly 97 percent of the annual costs. Installation costs account for less than one percent of total costs in the same year, a significant drop from its earlier 35 percent share in 1977.

The increasing share of operation, maintenance and administration costs over the study period is attributed in part at least to the growth in the stock of new apartment building suites. As the stock increases over time, an increasingly higher number of customer accounts must have their meters read and recorded regularly. As a result, the costs associated with this process become more pronounced. Installation and contracting costs, on the other hand, are basically capital costs which are

FIGURE 3.3
COST CATEGORIES AS A PERCENT
OF TOTAL COSTS



invariant to the existing stock of new apartment building suites. After a new building is constructed and available for occupancy, additional installation and contracting expenditures are no longer required. As shown in Table 3.3, these cost components are nevertheless significant and together amount to nearly \$30 million over the study period and represent about two thirds of the total tangible costs associated with individual metering.

3.3 OVERALL TANGIBLE BENEFITS AND COSTS

The net tangible benefits associated with individual metering are presented in Table 3.4 and shown graphically in Figure 3.4. The dollar entries under columns (1) and (2) of Table 3.4 indicate the annual benefits and costs, respectively, while column (3) of the same table shows the annual net benefit - that is, total benefits less total costs for each year. The last column indicates the accrued dollar value of net benefits for any given year over the study period. Net costs are identified by brackets. In Figure 3.4, the shaded area represents the dollar value of net benefits.

As can be seen in both Figure 3.4 and Table 3.4, a move to individual metering for new gas heated and all electric apartment buildings means an overall tangible net benefit of nearly \$19 million during the next 25 years. Initially, such a move results in an annual overall net cost of about \$2 million, as shown under column (3) of Table 3.4 and it is not until 1982 that subsequent benefits are sufficient enough to result in an overall net benefit. On the average, annual net benefits amount to about \$.7 million throughout the study period.

TABLE 3.4

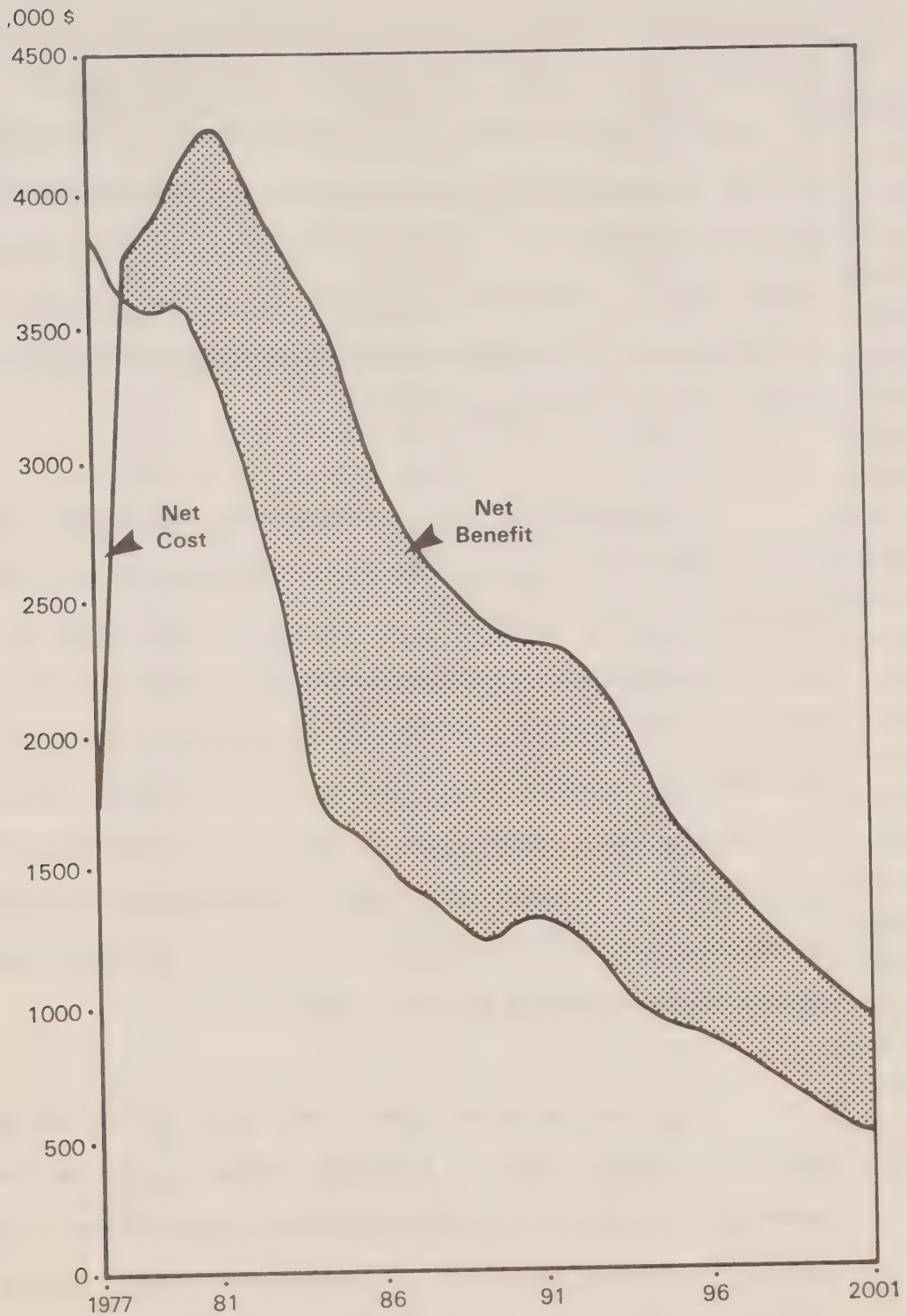
PRESENT WORTH OF NET BENEFITS FOR INDIVIDUAL METERING
IN YEAR SHOWN¹
1977 \$'THOUSANDS

Year	(1) Annual Benefits	(2) Annual Costs	(3) Net Benefits ²	(4) Cumulative Net Benefits ²
1977	1,785	3,826	(2,042)	(2,042)
1978	3,641	3,641	-	(2,042)
1979	3,780	3,502	278	(1,764)
1980	3,988	3,532	455	(1,308)
1981	4,239	3,324	915	(393)
1982	3,995	2,786	1,209	817
1983	3,679	2,253	1,426	2,243
1984	3,521	1,745	1,776	4,019
1985	3,052	1,601	1,452	5,471
1986	2,827	1,485	1,342	6,813
1987	2,585	1,330	1,255	8,067
1988	2,438	1,321	1,117	9,185
1989	2,301	1,218	1,083	10,267
1990	2,293	1,303	990	11,257
1991	2,318	1,298	1,020	12,277
1992	2,234	1,205	1,029	13,306
1993	1,936	1,001	936	14,242
1994	1,691	926	764	15,006
1995	1,565	853	712	15,718
1996	1,429	807	622	16,340
1997	1,329	742	587	16,927
1998	1,192	672	520	17,447
1999	1,066	606	460	17,907
2000	945	548	397	18,304
2001	860	480	380	18,864
TOTAL	60,689	42,005	18,684	-

Notes:

1. Detail May Not Add Due To Rounding.
2. Net Costs Are Indicated By Brackets.

FIGURE 3.4
SUMMARY OF NET BENEFITS



On the surface it appears that there are net tangible benefits to be gained with a move to individual metering in both gas heated and all electric apartment buildings. A closer look at the distribution of overall net benefits, however, indicates that in the case of gas heated apartments an overall net cost is realized. This is shown by columns (3) and (4) in Table 3.5. Annual benefits as shown under column (1) are not sufficient enough to outweigh the magnitude of annual costs as shown under column (2) in any given year throughout the study period. Total benefits amount to only \$10.5 million while total costs are \$23.7 million over the same period, so that a net overall cost of \$13.2 million is evident by adopting individual metering in new gas heated apartment buildings.

The overall net cost associated with gas heated apartment buildings is attributed in part at least to the relatively low energy difference found and discussed in Section II of this report. The statistical results indicated that residents in gas heated apartment buildings with bulk meters consumed, on average, only 657 kilowatt hours more electricity per annum than those with individual meters. Compared with the energy difference of 2,870 kilowatt hours reported for all electric apartment buildings, this energy difference is considerably lower and consequently translates into energy and capacity benefits which are insufficient to off-set the associated costs of individual metering over the 25 year period.

The distribution of benefits and costs for new all electric apartment buildings is shown in Table 3.6. Annual benefits and costs are presented under columns (1) and (2), respectively, while columns (3) and (4) show the annual and cumulative net benefits, respectively, for any given year throughout the study period. In this case, the total annual benefits of

TABLE 3.5

PRESENT WORTH OF NET COSTS FOR INDIVIDUAL METERING OF GAS HEATED SUITES
IN YEAR SHOWN¹
1977 \$'THOUSANDS

<u>Year</u>	(1) <u>Annual Benefits</u>	(2) <u>Annual Costs</u>	(3) <u>Net Costs</u>	(4) <u>Cumulative Net Costs</u>
1977	200	2,130	1,912	1,912
1978	450	2,030	1,573	3,485
1979	500	1,950	1,448	4,933
1980	549	1,969	1,419	6,352
1981	611	1,851	1,245	7,598
1982	601	1,551	959	8,556
1983	596	1,266	670	9,227
1984	631	981	355	9,582
1985	560	900	347	9,929
1986	531	841	312	10,241
1987	498	758	259	10,499
1988	475	755	277	10,776
1989	452	692	242	11,018
1990	445	745	296	11,315
1991	439	739	299	11,614
1992	424	684	262	11,876
1993	384	574	190	12,066
1994	348	538	184	12,250
1995	325	495	167	12,417
1996	301	461	164	12,581
1997	282	422	147	12,728
1998	260	390	130	12,857
1999	238	358	110	12,971
2000	217	317	103	13,075
2001	203	283	80	13,154
TOTAL	10,529	23,689	13,154	-

Note:

1. Detail May Not Add Due To Rounding.

TABLE 3.6

PRESENT WORTH OF NET BENEFITS FOR INDIVIDUAL METERING
OF ALL ELECTRIC SUITES IN YEAR SHOWN¹
1977 \$'THOUSANDS

Year	(1) Annual Benefits	(2) Annual Costs	(3) Net Benefits ²	(4) Cumulative Net Benefits ²
1977	1,575	1,705	(129)	(129)
1978	3,191	1,611	1,572	1,443
1979	3,280	1,560	1,727	3,170
1980	3,439	1,569	1,875	5,044
1981	3,628	1,468	2,161	7,205
1982	3,394	1,224	2,168	9,373
1983	3,083	983	2,097	11,470
1984	2,890	760	2,131	13,601
1985	2,492	692	1,798	15,400
1986	2,296	646	1,654	17,053
1987	2,087	577	1,514	18,567
1988	1,963	563	1,394	19,961
1989	1,849	529	1,325	21,286
1990	1,848	568	1,286	22,572
1991	1,879	559	1,319	23,891
1992	1,810	520	1,292	25,182
1993	1,553	423	1,125	26,308
1994	1,343	393	949	27,256
1995	1,240	360	878	28,134
1996	1,129	349	787	28,921
1997	1,047	317	734	29,655
1998	932	282	650	30,304
1999	828	258	574	30,878
2000	728	228	480	31,378
2001	657	197	459	31,837
TOTAL	50,150	18,320	31,837	-

Note:

1. Detail May Not Add Due To Rounding.
2. Bracket Indicates Net Cost.

\$50 million are appreciably higher than the total annual costs of \$18 million and result in a net benefit of nearly \$32 million. The net benefit from the all electric case is large enough to outweigh the costs associated with the gas heated case and result in an overall net benefit amounting to nearly \$19 million over the period of analysis.

It is interesting to note that almost two thirds of the net cost in the gas heated case is incurred within the first six years. This is shown as the initially large shaded area representing the net cost of individual metering in Figure 3.5 (a). As the diagram indicates, net costs are considerably lower after 1983, averaging about \$.2 million per annum. Net costs for all electric buildings, on the other hand, are only evident the first year as shown in Figure 3.5 (b). After 1977, annual net benefits averaging \$1.3 million are realized with the adoption of individual metering in new, all electric apartment buildings.

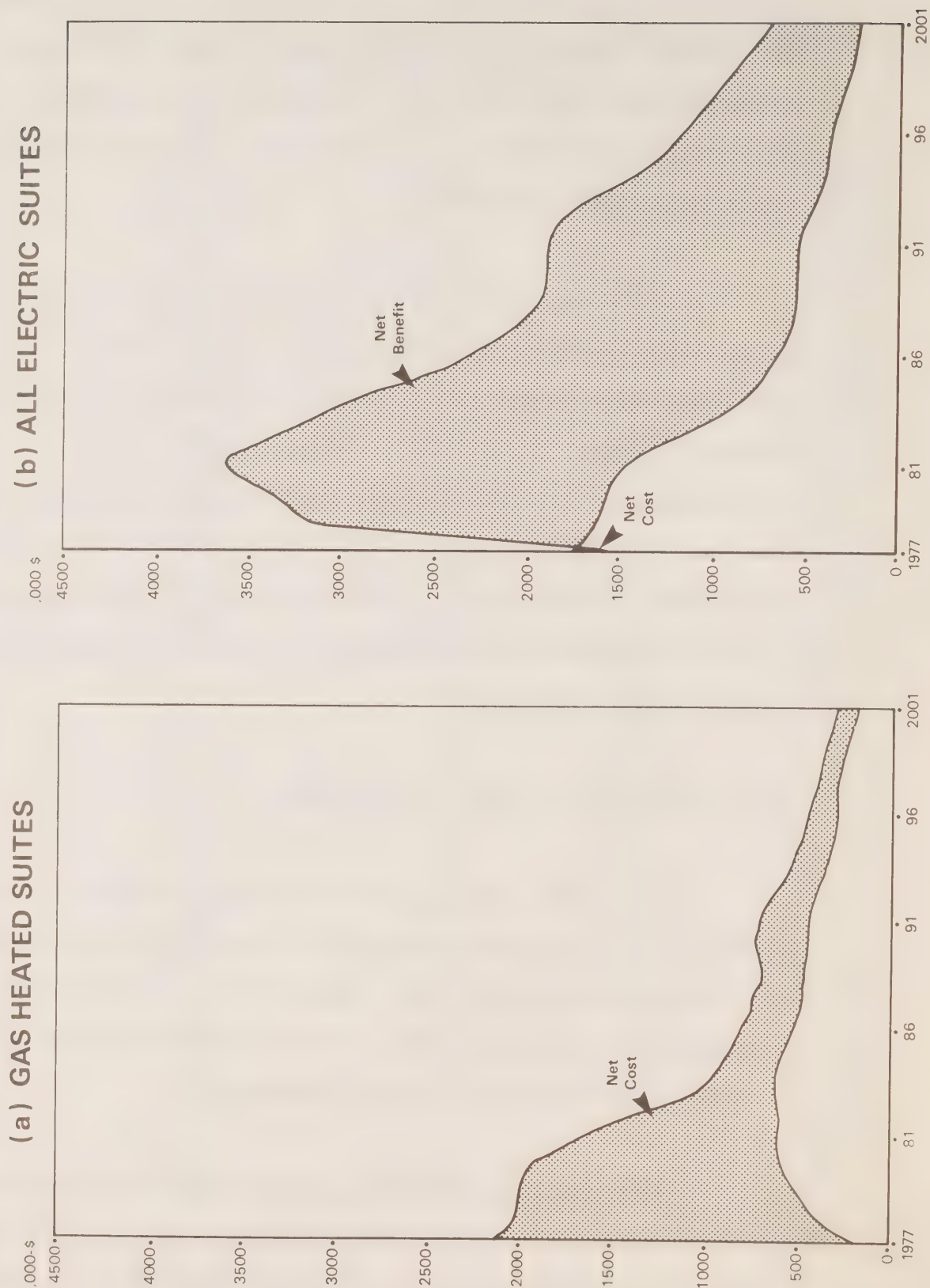
3.4 DISTRIBUTION OF BENEFITS AND COSTS

It was shown in the previous section that the province as a whole would be better off in a material sense with a move to individual metering. This is not to say, however that everyone in the province would be materially better off by such a move at least in part because of the nature of the benefit and cost components under consideration.

Additional goods and services such as meters, wiring materials, and so on must be used to achieve the overall net benefits from individual metering, yet, the major contributors of these resources may not turn out to be the direct recipients of the overall benefits. Moreover, the point was

FIGURE 3.5

DISTRIBUTION OF NET BENEFITS BY TYPE OF FUEL



made earlier that in certain situations, income distributional effects may result in some consumers and/or producers being made better off by making others correspondingly worse off. While a thorough evaluation of such income distributional effects is considered beyond the scope of this report, it is possible to make some specific comments about the nature of tangible benefit and cost components in terms of the way in which they are likely to be distributed.

An overview of the benefit and cost components is presented in Table 3.7. The tangible items are listed separately under column (1) with their corresponding values for gas heated and all electric apartment buildings shown in columns (2) and (3), respectively. Total dollar values for each benefit and cost category are entered under column (4).

A move to individual metering will likely result in an increase in the overall cost of constructing new apartment buildings. Additional wiring, needed for individual meters, areas to house these meters and additional labour requirements are the main factors which contribute to these higher construction costs. As indicated in column (4), the costs, valued in present day dollars amount to nearly \$19 million and account for about 45 percent of the net costs associated with individual metering. Insofar as these costs are passed along to apartment building owners who in turn pass it along to their tenants in the form of higher monthly rents, then it follows that apartment dwellers ultimately bear the burden of the additional contracting expenses incurred as a result of individual metering.

TABLE 3.7

OVERVIEW OF NET BENEFIT AND COST
COMPONENTS¹
- VALUED IN 1977 DOLLARS -
THOUSANDS

(1) Benefit/Cost Components	(2) Gas Heated	(3) All Electric	(4) Total
1. Energy	7,306	22,342	26,648
2. Capactiy	3,223	27,818	31,041
(a) Net Benefit (1+2)	10,529	50,160	60,689
3. Contracting	9,777	8,916	18,693
4. Installation	5,921	4,145	10,065
5. Administration	7,792	5,455	13,247
(b) Net Cost (3+4+5)	23,490	18,515	42,005
(c) Overall Net Benefit (a-b)	(12,961)	31,645	18,683

Notes:

1. Detail may not add due to rounding.
2. Brackets indicate net costs.

It must be emphasized, of course, that there are many factors independent of construction costs which influence the level of monthly rents in any given situation and whether or not monthly rents will increase directly as a result of the higher construction costs associated with individual metering is subject to a high degree of uncertainty at the present time. In any event, it is likely that apartment building owners will initially bear the burden of contracting costs and part, if not all, may be reflected in higher rents.

The remaining 55 percent of the net cost associated with individual metering will be initially borne by the electrical supply authorities across the province. As can be seen in the last column of Table 3.7 additional installation and administration costs amount to more than \$23 million over the next 25 year period. In addition to these costs, electrical supply authorities will likely be faced with costs arising from "bad debts."

In general, apartment dwellers tend to be more transient than other customers who use electricity. Hence, from the viewpoint of the electrical supply authority, it is likely that a move to individual metering will be accompanied with an increase in dollar losses attributable to apartment dwellers who move without paying their bills. It should be noted, however, that as long as the incidence of bad debts remains the same following a move to individual metering, then, from a provincial point of view the costs can be regarded as distributional in the sense that the landlord incurs the loss under bulk metering while the supply authority incurs the loss under individual metering. Such distributional effects merely result in some individuals - landlords and building owners - being better off by making others - electrical supply authorities - correspondingly worse off.

Nevertheless, electrical supply authorities will more than likely be faced with higher administration costs than reported earlier, as a result of an increase in the number of bad debt write-offs. Moreover, as the stock of individually metered apartment buildings continues to grow, these dollar losses will become more pronounced over the years.

The present 1977 dollar worth estimates associated with bad debts following a move to individual metering are shown in Table 3.8. Columns (1) and (2) distribute the total bad debts in the year shown from Column (3) by gas heated and all electric apartment buildings, respectively, while the last column indicates the accumulated dollar losses in any given year.

As can be seen by Table 3.8, annual bad debt write offs average less than \$.2 million and accumulate to slightly over \$4.2 million for the period of analysis. Adjusting the administration cost component to reflect these dollar losses increases net costs from the electrical supply authority point of view to about \$27.5 million. As illustrated in Figure 3.6, bad debts initially account for a relatively small part of annual net costs associated with individual metering; but, after the mid-80's, these dollar losses account for nearly 20 percent of annual net costs.

TABLE 3.8

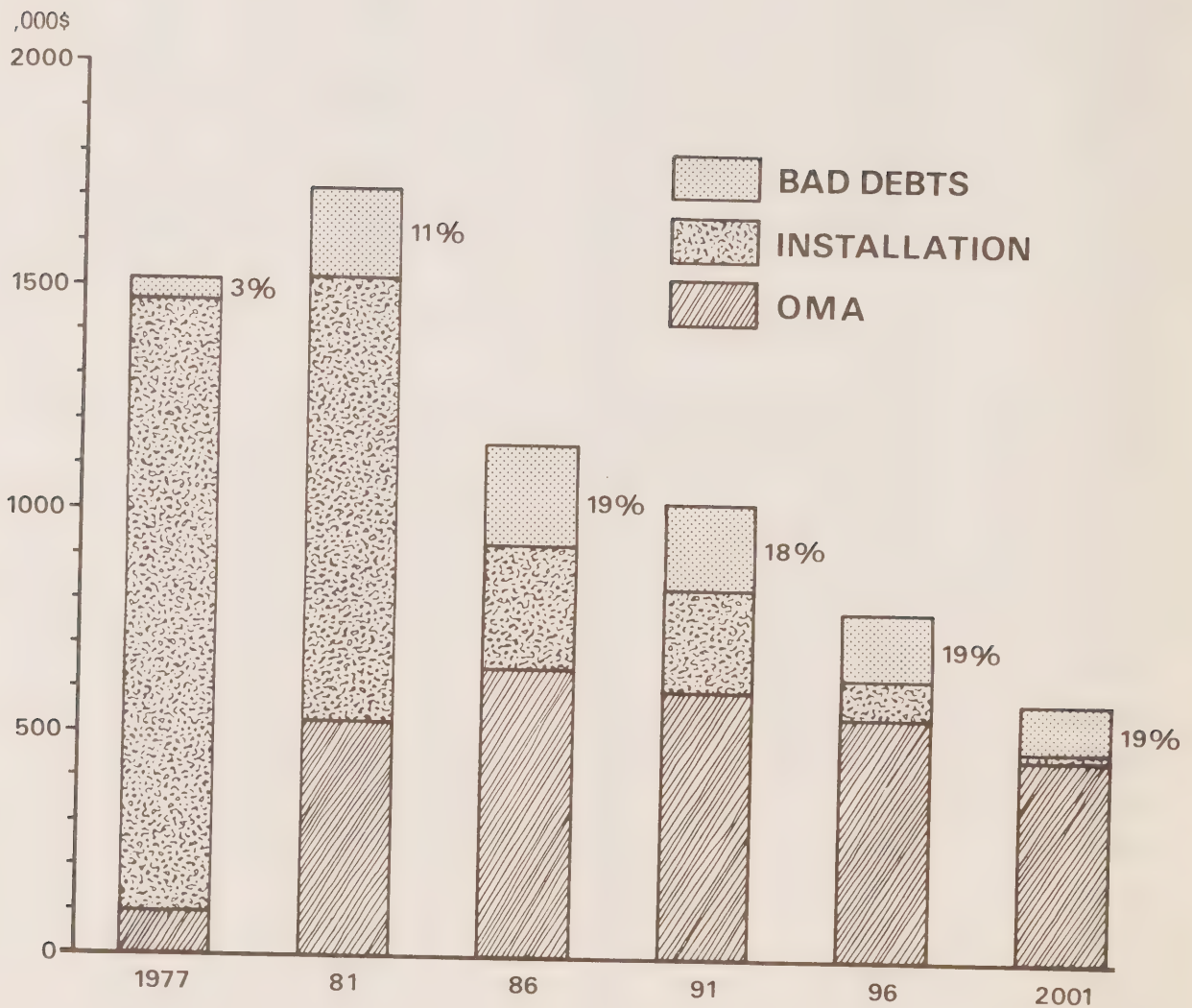
PRESENT WORTH OF BAD DEBTS ASSOCIATED WITH INDIVIDUAL METERING
IN YEAR SHOWN¹
1977 \$'THOUSANDS

<u>Year</u>	<u>(1) Gas Heated</u>	<u>(2) All Electric</u>	<u>(3) Total</u>	<u>(4) Cumulative Total</u>
1977	27	19	47	47
1978	53	37	91	137
1979	78	54	132	269
1980	98	69	116	436
1981	116	81	197	633
1982	128	89	217	850
1983	135	95	230	1,080
1984	137	96	233	1,313
1985	134	94	229	1,541
1986	129	91	220	1,761
1987	124	87	211	1,972
1988	120	84	204	2,176
1989	116	81	197	2,372
1990	113	79	192	2,565
1991	110	77	188	2,753
1992	109	76	185	2,938
1993	103	72	175	3,113
1994	98	69	167	3,280
1995	93	65	158	3,438
1996	89	62	151	3,589
1997	84	59	143	3,732
1998	79	56	135	3,867
1999	75	52	127	3,994
2000	70	49	120	4,114
2001	66	46	111	4,225
TOTAL	2,485	1,740	4,225	-

Notes:

1. Detail may not add due to rounding.

FIGURE 3.6
DISTRIBUTION OF NET COSTS INCURRED BY
ELECTRICAL SUPPLY AUTHORITIES
IN YEAR SHOWN



On the surface, it appears that revenues from the sale of electricity would have to be increased by a sufficient amount to off-set the increased cost of individual metering. It must be recognized, however, that the reduced electrical demands placed on the system can be translated into cost savings in the sense that capacity and energy benefits can be associated with not having to provide additional electricity. As shown in Table 3.7, these benefits, or cost savings amount to nearly \$60.7 million and, from the supply authority's point of view, are more than sufficient to off-set the increased costs of administration and installation. In other words, it is likely that total revenue requirements will be reduced by about \$33.2 million with a move to individual metering.

It was mentioned in Section II of the report that the prevailing rate structure for utility service enables the bulk metered customer to purchase the same amount of electricity as would be consumed by the tenants at a lower price by acting as a single customer. To the extent that the prevailing rate structure continues, then it is more than likely that a move to individual metering will be accompanied with an increase in sales revenue on the part of the supply authority even though, on average, annual consumption levels decrease. From the customer's point of view, of course, utility payments are increased by exactly the same amount.

Presumably, a reduction in the total revenue requirement by local supply authorities would be eventually passed on to its customer, however distributed, so that electricity users ultimately receive the net tangible benefits to be derived from a move to individual metering.

3.5 SENSITIVITY ANALYSIS

To evaluate the tangible benefits and costs of individual metering, it was necessary to incorporate a number of simplifying assumptions during the estimation procedure. To the extent that the estimates are sensitive to variations in these assumptions it is important to identify potential sources and likelihood of error in the final outcome; that is, to determine the degree of confidence in the results.

Accordingly, those benefit and cost categories having the greatest impact on the final outcome are identified by means of sensitivity analysis. Essentially, this process involves changing the estimate for one category by a given percentage while holding all others constant and recalculating the final outcome. Sensitivity analysis was applied to all tangible benefit and cost categories. The results for the major categories are summarized in Table 3.9.

A measure of the responsiveness of the final outcome to changes in estimates for benefit and cost categories is shown in column (1) and designated as a sensitivity elasticity. It is defined as the percentage change in the tangible net benefit divided by the percentage change in the benefit/cost category that brought it about. The value for the sensitivity elasticity of installation, for example, implies that a 10 percent increase (decrease) in the cost of installing individual meters would have the effect of reducing (increasing) the overall net tangible benefit by 5 percent.

TABLE 3.9

SENSITIVITY ANALYSIS

<u>Benefit and Cost Categories</u>	(1) <u>Sensitivity Elasticity¹</u>	(2) <u>Margin of Error to Reduce Net Benefit to Zero</u>
		-Percent -
(a) <u>Benefits:</u>		
1. Energy (i) KWh difference	+3.2	-36.9
(ii) \$/KWh	+1.6	-63.0
2. Capacity (i) KW difference	+1.5	-66.2
(ii) \$/KW	+1.7	-60.2
(b) <u>Costs:</u>		
1. Installation \$	-0.5	+185.6
2. Contracting \$	-1.0	+100.0
3. Operation Maintenance Administration \$	-0.7	+141.0

Note:

1. The sensitivity elasticity is defined as the percentage change in the overall net benefit arising from a given percentage change in a benefit/cost category.

$$\text{ie: Sensitivity Elasticity} = \frac{\% \text{ Change in overall Net Benefits}}{\% \text{ Change in Benefit/Cost Category}}$$

Generally speaking, a sensitivity elasticity having a value of one implies that a 10 percent change in a specific benefit/cost category results in a 10 percent change in the overall net benefit. A value of less (more) than one implies that a 10 percent change in a given category changes overall net benefits by less (more) than 10 percent. Moreover, a benefit/ cost category is said to have a significant, moderate or insignificant impact on overall net benefits whenever the absolute value of the sensitivity elasticity is greater than, equal to or less than one. The closer the value is to zero the less significant the relative impact on overall net benefits. As the absolute value increases beyond one, the more significant the relative impact.

A comparison of the sensitivity elasticities for the various benefit and cost categories listed in Table 3.9 indicates that changes in either energy or capacity estimates have a relatively significant impact on net benefits while similar changes on the cost side have a moderate or insignificant impact. The most significant category is the physical energy estimate; that is, the consumption differences between bulk and individually metered apartment buildings. If the electrical energy difference is lowered by 10 percent - 2502 kilowatt hours instead of 2780 kilowatt hours and 591 kilowatt hours instead of 657 kilowatt hours for all electric and gas heated apartment buildings, respectively - then net tangible benefits are reduced to \$12.7 million, representing a 32 percent change. Of course, if electrical energy differences turn out to be 10 percent higher, net tangible benefits are increased to \$24.7 million which also represent a 32 percent change.

It should be noted that a change in the physical energy difference also affects capacity estimates in the same direction, which accounts for the relatively high sensitivity elasticity associated with this benefit category. The other benefit categories, while relatively significant, have sensitivity elasticities well below +3.2.

On the cost side, changes in the dollar estimates for installation and operation, maintenance and administration have a relatively insignificant impact on the overall net tangible benefits. Contracting costs have a relatively moderate impact. A ten percent dollar increase (decrease) for this category decreases (increases) net benefits by the same percentage.

Column (2) of Table 3.9 shows the margin of error required to reduce the net tangible benefit to zero; that is, the point at which total benefits from individual metering are exactly off-set by the costs it incurs. Positive values imply lower estimates while negative values imply higher estimates. For instance, contracting costs associated with individual metering would have to be 100 percent higher than those used in this report before overall net benefits are reduced to zero. Similarly, dollar values for capacity benefits would have to be about 60 percent lower.

As the values indicate, almost all categories require a margin of error considerably higher than 50 percent before net benefits are reduced to zero. Only in one case, is the margin of error less than 50 percent. A 37 percent decrease in the physical energy differences is sufficient to reduce net benefits to zero. Compared with other categories, this margin appears

to be small but is nevertheless large in absolute terms. It is interesting to note that the highest margin of error is found in the installation cost category. Estimates for this cost category must be over 185 percent higher before net benefits are reduced to zero.

Given the magnitude of error required in each category to reduce net tangible benefits to zero and their respective elasticities, results of the sensitivity analysis seem to confirm net benefits with the adoption of individual metering.

During the statistical discussion in Section II, it was pointed out that data limitations prevented the examination of electrical consumption patterns in oil heated apartment buildings. Accordingly, the analysis has been confined to all electric and gas heated apartment buildings. To the extent that electrical consumption differences in oil heated buildings are equal to those found in the case for gas heated buildings, a move to individual metering in all apartment buildings over the next 25 years will mean an overall net benefit of about \$16.5 million. Additional benefits and costs in the oil heated case would amount to \$1.9 million and \$4.1 million, respectively, resulting in a net cost of \$2.2 million over the 25 year period.

It should also be noted that the apartment building forecast was based on the assumption that about 35 percent of all new apartment buildings constructed in Ontario over the next 25 years would be all electric. Given the more recent trend towards all electric multiple dwelling units, it may be argued that this estimate is somewhat on the conservative side. A more liberal estimate would be in the order of 50 percent. Assuming this to

be the case then the original net benefit of \$18.7 million would increase appreciably and amount to \$36.1 million, almost a 100 percent increase. The volatile nature of the housing market in general, however, makes it difficult to ascertain with a reasonable degree of accuracy the future penetration of all electric apartment buildings in Ontario and for this reason, a conservative estimate was initially used.

The tangible benefit and cost categories estimated and presented throughout the report were derived on the basis of a 15 percent discount rate. Table 3.10 provides a summary of the net effect on the overall tangible net benefit when the benefit and cost categories are subjected to various nominal discount rates, ranging from 10 percent to 25 percent. As indicated by the values entered in the last row of the table, an overall net benefit is realized with a move to individual metering, regardless of the discount rate employed.

Moreover, the value of net benefits as shown in row (a) increases significantly as the discount rate is lowered. Although net costs, shown in row (b), behave in a similar fashion, the relative changes are much less dramatic. Accordingly, overall net benefits increase significantly as the discount rate is lowered.

It is important to note that in the context of this report, the discounting procedure is intended to reflect in part at least the time value of money. In general, a high discount rate places greater emphasis on the near term benefit and costs while a low discount rate places greater emphasis on the long term effects. It is difficult to determine precisely

TABLE 3.10
SUMMARY OF SENSITIVITY ANALYSIS FOR VARIOUS
DISCOUNT RATES¹
\$'THOUSANDS

(1) Benefit/Cost Components	(2) 10%	Nominal Discount Rates		
		(3) 15%	(4) 20%	(5) 25%
1. Energy	59,184	29,648	20,347	13,545
2. Capacity	43,113	31,041	24,041	19,381
(a) Net Benefit (1+2)	102,297	60,689	44,388	32,926
3. Contracting	21,341	18,693	15,692	13,431
4. Installation	11,590	10,065	8,498	7,319
5. Administration	24,268	13,247	8,038	5,321
(b) Net Cost (3+4+5)	57,199	42,005	32,229	26,071
(c) Overall Net Benefit (a-b)	45,098	18,683	12,160	6,855

Note:

1. Detail may not add due to rounding.

which discount rate is the most appropriate in any given situation and for this reason no particular rate is advocated here. However, it is maintained that a low rather than a high discount rate is preferable in the present context. The rationale for this is discussed more fully in sub-section 3.7.

3.6 METERING STATUS OF EXISTING APARTMENT BUILDINGS

During the discussion of the framework of the analysis in Section 2.3 of the report, it was pointed out that a preliminary investigation into the status of existing apartment buildings in Ontario revealed that a number of serious drawbacks would be encountered in altering these buildings to accommodate a different type of metering practice. Some of the major drawbacks are discussed below.

An important factor to consider in a conversion policy is the cost associated with changing the building design in a suitable manner to accommodate individual meters, particularly in apartment buildings originally designed for bulk meters. It was estimated that conversion costs for these structures could run into thousands of dollars per apartment suite. The cost of converting apartment buildings presently equipped with bulk meters, but originally designed to accommodate individual meters would in all likelihood be considerably lower.

In general, the costs of conversion are influenced by several factors. Spatial requirements for individual meters could pose a serious problem in many apartment buildings. In bulk metered apartment buildings the electrical distribution is usually provided in a separate closet with an

overall inside width of about four feet. This closet contains the electrical distribution panel and the telephone distribution system. Typically, the distribution panel for such applications would have an average width of about thirty inches. If individual metering were required, the cabinet would be considerably wider, in the neighbourhood of about sixty inches, and would not fit into the existing cupboard space provided in the building as constructed. Either the existing closet would have to be enlarged or the distribution panel would have to be moved to a different location. In any event, it is likely that significant costs would be incurred in the process.

In some apartment buildings, particularly those which have been wired at minimum cost during initial construction, apartment suites share feeder lines under bulk metering. A conversion to individual metering would be more complicated in such cases because of the rewiring involved. In older apartment buildings, the electrical wiring is generally situated behind plaster and would require significant structural work and refinishing after a conversion to individual metering.

Finally, a major factor influencing the cost of conversion is the type of heating used in the building. Generally speaking, costs would tend to be much higher for electrically heated apartment buildings than those heated by fossil fuels such as oil and natural gas. In electrically heated buildings, apartment suites usually have separate feeders for appliance and lighting use and for heating purposes. This feature complicates a conversion to individual metering and tends to add significant costs in the process.

It is important to note that local supply authorities will likely incur significant administrative costs.⁶ These will include the cost of contacting building owners, arranging schedules, checking installations and expanding current facilities to handle the increase in customer accounts. Administrative costs will likely vary appreciably among supply authorities in Ontario, depending in part at least on the number of apartment suites involved.

Because of the many variable factors involved, it is difficult to ascertain the total cost of converting apartments from bulk to individual metering and hence the overall net tangible benefit associated with such a program. Nevertheless, it is possible to estimate all other tangible benefit and cost categories and then compare these findings to a range of conversion costs. In order to do so, it is necessary to make a number of additional qualifying assumptions about the conversion process. The main assumptions based on buildings with six or more suites are:

- that about 550,000 apartment suites are located in Ontario;
- that approximately 450,000 apartment suites, or 82 per cent, are presently equipped with bulk meters;
- that about 360,000 apartment suites are located in buildings heated by fossil fuels (oil and natural gas) and are equipped with bulk meters;

6. Toronto Hydro estimated that administrative costs to carry out such a program in their service would amount to about \$2 million for the 61,000 suites involved.

- that about 90,000 apartment suites are located in all electric apartment buildings;
- that electrical consumption differences in oil heated buildings are equal to those found in the case for gas heated buildings; and
- that the actual conversion program takes place over a ten year period (1977-1986) at a rate of 45,000 apartment suite conversions per annum.

An overview of the net tangible benefit and cost components for conversion is provided in Table 3.II. Column (1) of this table lists the various benefit and cost categories, excluding conversion costs while columns (2) and (3) show the results for fossil fueled and all electric apartment buildings, respectively. The total values for each category are shown in the last column.

As can be seen in column (4), a conversion policy means an overall net benefit of about \$35.9 million for those categories listed. As expected, an overall net cost of \$9.1 million is realized in the fossil fuelled case. However, net benefits for all electric buildings amount to about \$44.9 million over the same period and are sufficiently large enough to offset the losses in the fossil fuelled case.

TABLE 3.11

OVERVIEW OF NET TANGIBLE BENEFIT AND COST
COMPONENTS FOR CONVERSION¹
- VALUED IN 1977 DOLLARS -
THOUSANDS

(1) Benefit/Cost Components	(2) Fossil Fuelled ²	(3) All Electric	(4) Total
1. Energy	21,655	23,650	45,304
2. Capacity	9,533	31,521	40,892
(a) Net Benefit (1+2)	31,188	55,008	86,196
3. Installation	18,547	4,637	23,184
4. Administration	21,724	5,431	27,155
(b) Net Cost (3+4)	40,272	10,068	50,339
(c) Overall Net Benefit (a-b) (Excluding Conversion Costs)	(9,083)	44,940	35,857

Notes:

1. Detail may not add due to rounding.
2. Bracket indicates net cost.

It is interesting to note that most of the benefits from conversion are attributable to the all electric apartment buildings while the majority of costs are incurred in the fossil fuelled buildings. The relatively large energy differences found in all electric buildings account for the proportionately higher benefits realized over the study period. At the same time, it was estimated that these buildings only account for about 20 per cent of the conversion cases so that installation and administration costs are relatively small for this class of apartment buildings.

The effects of various conversion estimates on the overall net tangible benefits are summarized in Table 3.12 for each category of buildings. As shown in column (1) of this table, five conversion cases are considered. The first case listed shows the cost of conversion that would be sufficiently large enough to offset the net tangible benefits shown in Table 3.11. In otherwords, if the present 1977 cost of conversion on a per suite basis amounts to \$80 in both fossil fuelled and all electric apartment buildings, then the total cost of converting these buildings will be equal to the overall net tangible benefits. As shown in column (3), net benefits are still evident in the all electric case but these are offset by the net cost for the fossil fuelled case.

The second case listed indicates the maximum allowable cost of conversion before the net tangible benefits from individual metering in new apartment buildings over the next 25 years are reduced to zero. It shows that a move to individual metering in all apartment buildings in Ontario (both new and existing buildings) would result in net tangible benefits insofar

TABLE 3.12

RANGE OF COVERION ESTIMATES AND THEIR
EFFECTS ON NET TANGIBLE BENEFITS¹
- VALUED IN 1977 DOLLARS -
\$ THOUSANDS

<u>Net Tangible Benefits</u> ²				
	(1) Conversion Costs <u>\$ per suite</u>	(2) Fossil <u>Fuelled</u>	(3) All <u>Electric</u>	(4) <u>Total</u>
1.	80	(37,769)	37,769	--
2.	116	(50,965)	34,469	(16,496)
3.	500	(188,843)	--	(188,843)
4.	(a) Fossil - 500			
	(b) Electric - 1,000	(189,083)	(45,060)	(234,143)
5.	(a) Fossil - 1,000			
	(b) Electric - 2,000	(369,083)	(135,060)	(504,143)

Notes:

1. Detail may not add due to rounding.
2. Brackets indicate net costs.

as conversion costs are less than \$116 per suite. Even at this estimated amount, net benefits of \$34.5 million are still realized in the all electric case. Conversion estimates would have to average about \$500 per suite before the net benefits in all electric apartments are equal to the net costs. This is shown as the third case.

The last two cases listed in Table 3.12 show separate estimates for fossil fuelled and all electric apartment buildings. Estimated costs are higher in the latter case than in the former case to reflect the greater difficulties anticipated in converting these buildings to individual metering. The last case listed shows the effect on net tangible benefits using the conversion cost estimates found in this report. It is felt that the estimates shown in cases (4) and (5) are more than likely indicative of actual conversion costs than those previously cited. Moreover, these estimates appear to be in line with conversion estimates reported in other studies.⁷

As shown in column (4), significant net tangible costs are realized with conversion costs ranging from \$500 to \$2,000 per suite. In the last case with conversion estimates of \$1,000 and \$2,000 per suite for fossil fuelled and all electric apartments, respectively, total tangible costs amount to over half a billion dollars. Even in the all electric buildings, significant costs are incurred, ranging from \$45 million to \$135 million in cases (4) and (5), respectively.

7. Toronto Hydro, for example, estimated that conversion costs would vary between \$800 and \$2,000 per suite. Similarly, the Mid-West Research Study reported conversion costs ranging from \$100 to \$1,200 per apartment unit.

To the extent that conversion costs are in the neighbourhood of those cited in the last two cases, then a move to individual metering would more than likely result in substantial overall tangible costs. Moreover, significant costs are realized even in the case of existing all electric apartment buildings where the energy differences are most pronounced.

3.7 INTANGIBLE BENEFITS AND COSTS

There are additional benefits and costs associated with individual metering that are not typically priced in the market place, but are nevertheless real. Designated as intangibles in the context of this report, they include items such as conservation benefits, external benefits and consumers' surplus costs as well as other benefits and costs.

The extent to which these types of considerations are evaluated in a study such as this depends not only on the relative importance attached to each intangible item, but also on whether or not they can be quantified with a reasonable degree of confidence. In situations where the quantification of intangibles are based on either extremely naive or questionable assumptions, it would seem inappropriate to attempt an explicit dollar measurement of these in the initial calculations. Instead, after careful itemization and measurement of all other tangible categories of benefits and costs it would seem more appropriate to compare these findings with the non-monetary or intangible benefit and cost categories.

Essentially, this is the approach adopted in this report. Intangible benefits and costs are merely identified and for the most part discussed in general terms. Explicit dollar measurements are provided in a few cases to give some indication of their monetary value. The dollar estimates shown, however, are only crude approximations and the reader should be cautioned against attaching undue confidence to these results.

The intangible benefits and costs discussed in this report are not meant to be exhaustive. Given the scope and the nature of the topic under investigation, it is likely that additional intangible items could be cited. It is felt, however, that those discussed in this report are the most significant.

3.8 CONSERVATION BENEFITS

There are conservation benefits attributable to individual metering in the sense that additional value could be added to the net benefits representing the value of redistributing current consumption to future consumption. The difficulty, of course, is determining how much value should be attributed to electrical consumption savings in the interest of conservation. Regardless of the yardstick employed, any dollar measurement of conservation benefits is questionable and subject to considerable debate because it is not entirely clear what value there is in having an extra unit of energy some time in the future. Furthermore, it is difficult to ascertain whether the costs of postponing consumption today exceed the benefits derived from future generations who are able to use more.

Given that it is desirable to redistribute current consumption to future consumption, adjustments could be made in the discount rate to reflect this preference. Since a high discount rate places greater emphasis on the near term while a lower rate places greater emphasis on the long term, it could be argued that a low discount rate should be used to evaluate the tangible benefits and costs in this particular study. As was shown in Table 3.10, the lowering of the discount rate has the effect of increasing the value of the overall net benefit which in turn makes individual metering seem more attractive. Again though, it is difficult to ascertain precisely which discount rate is the most appropriate. Too low a rate would over-emphasize future consumption while too high a rate would over-emphasize current consumption.

Although such measurement difficulties preclude the evaluation of conservation benefits in terms of monetary units, it is possible to make some specific comments about the extent of physical or kilowatt hour savings associated with individual metering.

As discussed in Section 2.8, potential electrical energy savings would accumulate to over 6.7 billion kilowatt hours with a move to individual metering. It is important to note, however, that this amount only reflects direct energy savings. To the extent that additional resources are necessary to accommodate such a move, the energy requirements of these goods and services should also be taken into account. In addition, the direct energy savings should be adjusted to take into account the energy requirements of the resources needed to provide electrical power. These types of adjustments reflect the indirect energy requirements.

Total energy savings, including the direct plus indirect energy requirements, are derived from Statistics Canada Energy Model.⁸

The energy model is an extension of input-output accounting, a technique which reflects the "roundabout" process of production inherent in most economic activities. To produce electricity, for instance, necessitates the efforts of not only those who are in the utility sector, but also those who are concerned with supplying materials embodied in the production of electricity. In turn, the production of these materials requires input from other supplying industries. Hence, the production of electricity affects the output of other industries in the economy through intermediary transactions needed to meet the initial production requirement.

Essentially, the energy model details the use of fuels required for the production of all goods and services in the economy. It operates within the same analytical framework as input output models with the added assumption that inputs of energy in physical quantities are proportional to the value of industry output. The significance of the energy model is that it enables the analyst to relate total fuel demand to the total level of production throughout the economy. This provides a means of measuring the impact on the total energy system of a given change in consumption levels.

Take for example, the situation where the demand for electricity by apartment dwellers decreases with a move to individual metering. The immediate or direct effect will be a reduction in the amount of electricity

8. For more detailed information see: Users' Guide to Statistics Canada Structural Economic Models, Structural Analysis Division, Statistics Canada (February 1976).

supplied by the utility sector. However, the economic process does not end here. A reduction in electricity consumption will effect other industries in the economy to the extent that these industries supply scarce resources such as capital and primary energy as intermediate goods for the production of electricity. The energy content of these intermediate transactions of indirect effects should be taken into account in assessing conservation benefits.

It is important to note, however, that the energy model details the flow of fuels among sectors at the national level only. In order to estimate total conservation benefits in Ontario, it was necessary to assume that economic interrelationships in the province are similar in relative terms to those of the Canadian economy as a whole. It is also important to bear in mind that the energy model is based on 1966 Input Output Accounts and as such, major structural changes which may have taken place over the last twelve years are not taken into account during the energy model simulations.⁹ It is felt, however, that these assumptions do not bias the model simulations appreciably.

Estimates from the energy model of the overall net energy requirements are shown in Table 3.13. Column (1) of this table lists the various benefit and cost items while column (2) and (3) show the energy requirements in terms of electric power and total energy, respectively.

9. The recent oil crisis, for instance, may have affected some industries more than others. Those industries faced with significant price increases may have altered their production process and hence their economic linkages with other trading industries.

TABLE 3.13

TOTAL ENERGY REQUIREMENTS ASSOCIATED WITH
INDIVIDUAL METERING

(1) Benefit/Cost Component	(2) Electric Power	(3) Total Energy
	- MWh's -	-Billions BTU's
1. Energy	7,169,615	58,464
2. Capacity	41,652	1,205
(a) Net Benefit (1+2)	7,211,267	39,669
3. Contracting	21,454	719
4. Installation	33,001	807
5. Administration	11,635	262
(b) Net Cost (3+4+5)	66,108	1,788
(c) Overall Net Benefit (a-b)	7,145,159	37,881

Note:

1. Detail may not add due to rounding.

As can be seen in row (C) of Table 3.13, a move to individual metering means overall conservation savings amount to 7.1 billion kilowatt hours of electric power and 37,881 billions of BTU's of total energy. The electric power requirements for each benefit and cost item listed have been adjusted to take into account line losses. To estimate the electric power requirements associated with capacity, it was assumed that the total kilowatt savings over the period of analysis would reduce capital requirements for a coal-fired generating facility. Hence, the electric power requirements of 41.7 million kilowatt hours reflects the additional amount of electricity that would have been used to construct and operate a coal-fired station with sufficient capacity to provide the additional kilowatt hours consumed by apartment dwellers with bulk meters. Similarly, the additional electric power associated with the fuel and variable operation and maintenance of the generating unit is included in item (I) of Table 3.13. The total amount of electric power associated with the benefit items is shown in row (A).

The electric power requirements associated with the additional goods and services to accommodate individual metering are also included in column (2). The total electric power requirements for the additional contracting, installation and administration amounts to 66.1 million kilowatt hours, as shown in row (B). It is interesting to note that the energy used in manufacturing electric meters, which comprises most of the installation cost component, accounts for nearly one half (about 33 million kilowatt hours) of the additional electric power requirements. The overall conservation savings of electric power as shown in row (C) of the same table amounts to about 7.1 billion kilowatt hours. These savings are equivalent to

supplying sufficient electrical power to a municipality the size of Toronto for one year, based on 1976 consumption levels.

Column (3) of Table 3.13 shows the total energy requirements measured in billions of BTU's for each of the benefit and cost components listed. The total energy requirements take into account the fuels such as oil, gas, coal, and electricity that are used to attain each of the benefit and cost items listed. In other words, the total amount of energy used to install individual meters over the next 25 years (cost components (4)) is equivalent to 807 billion BTU's. Similarly, the total energy used to construct and operate a coal-fired station with sufficient capacity to provide the additional kilowatt hours consumed by apartment dwellers with bulk meters amounts to 1,205 billion BTU's, as shown in row (2), column (2). The overall net conservation savings associated with all type of fuels amount to 37,881 billion BTU's over the 25 year period. This represents the energy equivalent of about 6.5 million barrels of crude oil, or about 3.8 per cent of Canada's 1976 exports of crude oil to the United States.¹⁰

3.9 EXTERNAL BENEFITS

There are external benefits associated with individual metering in the sense that value could be attributed to the reduction in environmental damage associated with the production of electricity. In practice, however, it is often extremely difficult to assign a dollar value to such externalities. Nevertheless, a survey of the literature in this area revealed that a number

10. Statistics Canada, Canadian Statistical Review. Cat. #11-003, (July 1977).

of studies have attempted to evaluate the social costs of atmospheric emissions attributable to electricity generation in dollar terms. The major findings from some of the most recent studies undertaken in United States and Canada are summarized in Tables 3.14 and 3.15, respectively.

The first three columns in both tables identify the author, the geographical area under consideration and the type of air pollutant monitored. As indicated in column (3), most of the studies confined their analysis to an examination of sulphur dioxide (SO_2) and/or oxides of nitrogen. Column (4) in both tables identifies the resource area evaluated while columns (5) and (6) show the total estimated damage and relative estimated damage, respectively.

Not surprisingly, the estimated dollar values shown in the last two columns of both tables vary considerably depending on the type of pollutant and resource area evaluated. However, the reader should be cautioned against attaching undue confidence to these estimates. In many instances, it is virtually impossible to evaluate the environmental damage of electricity generation in dollar terms. Moreover, the reported estimates only consider atmospheric emissions and their effects on building materials, miscellaneous products, vegetation, crop damage and animal life. Social costs may also include damage to health, loss of food lands, recreational opportunities, aesthetic deterioration and general nuisance or unpleasantness.

To give some indication of the value that could be attributed to the reduction in environmental damage associated with individual metering, it is assumed that the relative damage of air pollution from the production

TABLE 3.14

THE SOCIAL COSTS OF AIR POLLUTION - USA STUDIES

(1) Author	(2) Geographical Area	(3) Type of Pollutant	(4) Resource Area	(5) Total Estimated Damage	(6) Relative Damage
1. Fink, Buttner and Boyd (1971)	USA	SO ₂	Metal Products	\$1,450 Million	N/A
2. Gillette (1973)	USA	SO ₂	Metals and Paints	\$400 Million	N/A
3. Gillette (1975)	USA	SO ₂	Misc. Materials	\$909.4 Million - 1968 \$75.0 Million - 1972	N/A N/A
4. International Telephone And Telegraph (1971)	USA	SO ₂	Electrical Components	\$13.2 Million	N/A
5. Mueller and Stickney (1970)	USA	Ozone	Rubber Products	\$226 Million	N/A
6. Robbins (1970)	USA	SO ₂ , Organic Gases	Electrical Contacts	\$15 Million	N/A
7. Sagan (1974)	USA	Not Specified	All Areas	\$20,000 per 1000 MW Coal Fired generating station year	0.004 Mills/kWh
8. Salmon (1970)	USA	SO ₂	Misc. Materials	\$3,800 Million	N/A
9. Salvin (1970)	USA	NO ₂ , Ozone	Textile Fibres and Dyes	\$206 Million	N/A
10. Spence and Haynie (1972)	USA	SO ₂	Paints	\$704 Million	N/A
11. Waddell (1971)	USA	Not Specified	(a) Vegetation (b) All Areas	\$150 Million \$1.5 Billion	N/A 1.2 mills/kWh

Notes:

1. N/A - Not Available
2. SO₂ - Sulphur dioxide
3. NO_x - Nitrogen oxide

TABLE 3.15

THE SOCIAL COSTS OF AIR POLLUTION - CANADIAN STUDIES

(1)	(2)	(3)	(4)	(5)	(6)
Author	Geographical Area	Type of Pollutant	Resource Area	Total Estimated Damage	Relative Damage
1. Hill (1977)	Ontario	SO ₂	(a) Building Materials (b) Vegetation Damage (c) Crop Damage (d) Animals, Fish, Soil or Forest (e) Amenity Loss	Less Than \$1 Million/Per Plant Year Negligible \$Millions Negligible	Less Than 1% of Electr Generation Cost -- Difficult to Ascribe --
				N/A	N/A
2. zerbe (1969)	Canada Ontario Toronto	SO ₂	Misc. Materials	1965 - \$1,026.7 Million (Canada) - \$ 477.5 Million (Ontario) - \$ 185.7 Million (Toronto)	\$52.46/Capital \$70.94/Capital \$93.98/Capital
				1985 Forecast (1969 Dollars):	
3. Youston (1975)	Ontario	SO ₂ , NO _x	Buildings and Textiles	\$4.3 Billion (Canada) \$2.0 Billion (Ontario) \$1.8 Billion (Toronto) Nanticoke GS: \$3,140-\$16,560 Lakeview GS: \$41,900-208,950	\$115.38/Capital \$156.78/Capital \$207.70/Capital 0.002-0.008 Mills/kwh 0.03-0.17 Mills/kwh

Notes:

1. N/A - Not Available
2. SO₂ - Sulphur Dioxide
3. NO_x - Nitrogen Oxide

of electricity amounts to about one per cent of electric generation cost in any given year. Accordingly, the estimated social costs of pollution would amount to less than \$0.5 million for the energy differences reported in this study.¹¹

3.10 CONSUMERS' SURPLUS COSTS

An individual who purchases a particular good and/or service pays a price that is either equal to or less than the amount he would have been willing and able to pay. Take, for example, a situation where an individual is prepared to pay up to \$4,000 for a certain used car and for one reason or another ends up only paying \$3,500. Essentially, the individual realizes a "surplus" of satisfaction which represents the difference between what he was prepared or willing to pay for the car and what he actually paid. The money value of this "surplus" satisfaction - that is, \$4,000 less \$3,500 or \$500 - is the consumer surplus.

On the surface, it appears that a move to individual metering leads to a loss in consumers' surplus in the sense that the apartment dweller loses "surplus" satisfaction associated with the additional electricity which he no longer uses. From the overall perspective, however, there may be changes in surplus elsewhere in the economy that offset these losses.

It was noted in sub-section 3.4 that a move to individual metering would more than likely lead to a reduction in the total revenue

11. Estimated by taking one percent of the anticipated generating costs over the next 25 years, expressing the dollar value in terms of mills per kilowatt hour and applying this figure to the energy differences reported in Section 2.4.

requirement of local supply authorities. To the extent that these savings are passed on to its customers, then it follows that electricity users ultimately receive the net tangible benefits to be derived from such a move. Other things remaining equal, it is reasonable to assume that customers receiving these benefits, however distributed, would realize a gain in consumers' surplus because they end up paying less for the electricity they used. To the extent that customers who receive the benefits purchase additional goods and services, further changes in surplus will likely take place elsewhere in the economy.

There are, however, practical difficulties in evaluating both the direction and magnitude of such changes in consumers' "surplus."¹¹ In the first place, measurement difficulties are encountered in trying to determine the amount of money that apartment dwellers would be willing to pay for the additional electricity they use under bulk metering. It may turn out that some apartment dwellers would not be willing to pay any positive amount for the additional electricity they use simply because they are not aware of how much they are actually using. Measurement problems are further compounded in evaluating changes in consumers' surplus over a long period of time.¹² The amount of money that an individual is willing to pay today may differ appreciably with the amount of money the same individual is willing to pay some time in the future. Finally, dollar measurements of consumers' surplus are usually suspect and subject to considerable criticism regarding the simplifying assumptions used.¹³

11. In fact, some economists have gone so far as to conclude that consumers' surplus is no more than a "totally useless theoretical toy." See IMD Little, A Critique of Welfare Economics, New York, 1950.

12. To the extent that the demand function for electricity reflects the willingness to pay function, then the problem is one of assessing shifts in demand over time.

13. Such as the validity of assuming interpersonal comparisons of consumer surplus, constant utility for money and partial analysis.

Given both the theoretical and practical limitations in measuring the extent, if any, of consumers' surplus associated with either bulk or individual metering, this effect is merely identified. This is not to say that consumers' surplus is completely irrelevant. It is felt, however, that this item is relatively less important when compared with the other benefit and cost considerations in this report.

3.11 OTHER INTANGIBLE BENEFITS AND COSTS

There are additional intangible benefits and costs which may be associated with individual metering. Some of these are discussed below.

On the benefit side, a move to individual metering makes the apartment dweller aware of the consequences of using more or less electricity simply because he pays for what he uses. The apartment dweller who decides to use less electricity pays a lower monthly bill. Similarly, the apartment dweller who decides to use more electricity pays a higher monthly bill. Under bulk metering, however, the same apartment dweller is not aware of the consequences of using more or less electricity because the electricity bill is included in his rent. Moreover, the apartment dweller may doubt that he receives his fair share of the electricity he pays for. By paying his own monthly bill, a move to individual metering allows the final user to make his own consumption decision.

On the cost side, a move to individual metering means that the apartment dweller no longer has the convenience of one monthly payment for both rental accommodation and electricity usage. Moreover, there could

be additional difficulties encountered in a conversion program. Since the monthly rental payments include the charges for utility services, some apartment dwellers may doubt that their rents have been properly adjusted following a move to individual metering. Finally, some apartment dwellers in electrically heated buildings may be faced with above average bills simply because of the location of their suite in relation to others in the building complex. Since corner suites are more susceptible to weather conditions, apartment dwellers in these suites will likely require more electricity for heating purposes. The same is likely to be true for tenants residing next to vacant apartment suites where the service is temporarily disconnected. To the extent that electricity charges are equally distributed among tenants residing in a bulk metered apartment building, these burdens are equally shared by the tenants.

SECTION IV

4.0 CONCLUSIONS AND RECOMMENDATIONS

In Section II of this report it was shown that apartment dwellers who reside in bulk metered apartment buildings tend to use significantly more electricity than those who reside in buildings equipped with individual meters. Specifically, it was noted that the annual per suite electrical energy differences amounted to 657 kilowatt hours and 2,870 kilowatt hours for gas heated and electrically heated apartments, respectively.

Insofar as these energy differences remain at their respective levels over the next twenty-five years, it was shown that a move to individual metering for new apartment buildings in Ontario would benefit the province in dollar terms. While such a move means an increase of about \$42 million in operating and capital costs over the next 25 years, these costs are offset by benefits derived from the electrical energy differences. Total benefits amount to about \$61 million over the same period as that an overall net benefit of \$19 million is realized with a move to individual metering. In addition, it was pointed out that non-monetary gains would also be realized by such a move namely; electrical energy conservation; reduction in environmental damage; and, enabling the final user to pay for what he consumes.

An examination of the status of existing apartment buildings indicated that a conversion to individual metering would mean overall net costs which could reach \$500 million, depending on the costs incurred during the conversion period.

On the basis of the findings of the study it is recommended that:

1. FOR ALL NEW MULTIPLE UNIT RESIDENTIAL BUILDINGS THE ELECTRICAL CONSUMPTION OF EACH SELF CONTAINED DWELLING UNIT SHALL BE INDIVIDUALLY METERED.
2. FOR ALL NEW MULTIPLE UNIT RESIDENTIAL BUILDINGS EMPLOYING POINT OF USE ELECTRIC HEATING, THE ELECTRIC HEATING SHALL BE UNDER THE CONTROL OF THE UNIT OCCUPANT AND INCLUDED IN THE METERED ELECTRICAL CONSUMPTION OF THE UNIT.
3. FOR ALL NEW MULTIPLE UNIT RESIDENTIAL BUILDINGS, ELECTRICAL EQUIPMENT WHICH IS UNDER THE CONTROL OF THE BUILDING OWNER SHALL BE BULK METERED.
4. IN EXISTING MULTIPLE UNIT RESIDENTIAL BUILDINGS WHICH ARE NOT METERED IN A MANNER WHICH CONFORMS TO THE PRACTICE RECOMMENDED HEREIN FOR NEW MULTIPLE UNIT RESIDENTIAL BUILDINGS, THE METHOD OF METERING MAY BE ALTERED TO CONFORM WITH THE RECOMMENDED PRACTICE BY MUTUAL AGREEMENT BETWEEN THE SUPPLY AUTHORITY AND THE BUILDING OWNERS.
5. THE ABOVE RECOMMENDATIONS SHALL BE APPLICABLE TO ALL BUILDINGS WITH MORE THAN ONE SELF CONTAINED RESIDENTIAL DWELLING UNIT BUT WILL NOT BE APPLICABLE TO DWELLING UNITS USED FOR SHORT TERM OCCUPANCY SUCH AS THOSE IN HOTELS, MOTELS, ETC.

ADDENDUM

INTRODUCTION

The detailed calculations and related assumptions for the preceding analysis are shown here. Specifically, the following items are discussed:

A1.0 - Statistical Survey;

A2.0 - Apartment Building Forecast;

A3.0 - Tangible Costs; and

A4.0 - Tangible Benefits.

AI.0 STATISTICAL SURVEY

In co-operation with municipal electric utilities in the province of Ontario and Ontario Hydro's Retail System a survey of apartment buildings was undertaken. The information obtained from this survey ultimately served as the data bases to determine the extent of electrical energy differences between bulk metered and individually metered apartment buildings. The data gathering stage was accomplished in three phases.

During the first phase, survey forms were forwarded to all utilities concerned in order to determine the physical characteristics of existing apartment buildings throughout Ontario. The survey sheets used for these purposes are shown in Exhibit AI.1. Responses to this phase of the sampling procedure yielded completed questionnaires from a total of 2,281 buildings and 109, 442 suites.

An inspection of the data revealed that certain categories of buildings had characteristics which could not be statistically examined in a meaningful way when comparing actual electrical energy use patterns in bulk and individually metered apartment buildings. To avoid questionable comparisons these categories were excluded from further analysis. These types of buildings included:

Exhibit A1.1

ASSOCIATION OF MUNICIPAL ELECTRICAL UTILITIES
(OF ONTARIO)



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MANAGER
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TELEPHONE 592-3807
AREA CODE 416

January 20, 1977

TO: MEMBER UTILITIES

The Joint OMEA, AMEU, Ontario Hydro Study Team investigating electric metering (bulk and individual) of multiple unit dwellings urgently require your assistance in collecting data on actual electrical energy use patterns in Ontario.

The enclosed survey forms are being sent to all municipal utilities and identical forms are being used by Ontario Hydro to survey its service areas. Will you please complete sets of survey sheets for the number and types of buildings listed in attached instructions and forward them to the AMEU office in the enclosed, self-addressed envelope by February 15, 1977. If you have zero buildings in one or all of these types listed, please report that.

The information obtained from the survey questions will be for statistical purposes only and will remain confidential. The information will be reviewed and some buildings will be selected by the Joint Study Team for further examination. At this point, the municipal utility involved will be approached for further assistance.

The Joint Study Team stresses the importance of this survey and its significance in assisting the Team develop recommendations for a future policy on electrical energy metering for multiple unit dwellings in Ontario.

Yours truly,

W.R. Mathieson
General Manager

encl.

INSTRUCTIONS

FOR

CONDUCT OF A SURVEY OF MULTIPLE UNIT DWELLING
(more than five suites)

Please complete one set of sheets (2 pages) for each building reported and return with utility name to AMEU office by February 15, 1977.

Good statistical survey data requires a minimum sample size (number of buildings) in each category listed below. Where less than 10 exist, supply data on all buildings.

<u>METERING TYPE</u>	<u>TYPE OF HEATING</u>	<u>MINIMUM SAMPLE (no of bldgs) Size Required (if available)</u>
Bulk	Fossil Fuel	10
Individual	Fossil Fuel	10
Bulk	Electric	10
Individual	Electric	all *
Converted	Fossil Fuel	10
Converted	Electric	10

* As individually metered electrically heated apartment buildings are not common, data on all available buildings is desired.

TRI-PARTY APARTMENT SURVEY

PLEASE FILL IN ONE FORM FOR EACH BUILDING

A. PLEASE DESCRIBE YOUR BUILDING (MORE THAN 5 SUITES)

1. ADDRESS _____

2. DISTRIBUTION OF RENTAL SUITES BY SIZE
BACHELOR OR MONETTE _____
1 BEDROOM _____
2 BEDROOMS _____
3 BEDROOMS OR MORE _____
TOTAL SUITES _____
3. NUMBER OF FLOORS WITH RENTAL SPACE _____
4. THIS BUILDING WAS COMPLETED IN 19 _____
5. NUMBER OF ELEVATORS _____
6. NUMBER OF COMMERCIAL ESTABLISHMENTS IN YOUR BUILDING
(EXCLUDING COIN-OPERATING MACHINES) _____
7. TYPE OF OWNERSHIP OF THIS BUILDING (CHECK ONE)
____ PRIVATE COMPANY
____ CONDOMINIUM
____ CO-OPERATIVE
____ GOVERNMENT (ONTARIO HOUSING CORPORATION, ETC)
8. TYPE OF ELECTRICAL METERING IN BUILDING BULK ☐ INDIVIDUAL ☐

B. PLEASE DESCRIBE THE MAIN HEATING SYSTEM FOR YOUR BUILDING

1. MAIN HEATING FUEL
ELECTRIC ☐ GAS ☐ HEAVY OIL ☐ LIGHT OIL ☐ OTHER (DESCRIBE) ☐
(BUNKER C) _____
2. MAIN HEATING SYSTEM
WARM AIR ☐ HOT WATER ☐ ELECTRIC ☐ ELECTRIC ☐ OTHER (DESCRIBE) ☐
BASEBORD CEILING CABLE _____
3. WHAT TEMPERATURE THERMOSTATS ARE THERE?
ONE IN ☐ ONE IN ☐ ONE IN ☐ ONE IN ☐ OTHER (DESCRIBE) ☐
EACH EACH EACH EACH
ROOM SUITE WING FLOOR

4. ARE THERE ANY HEAT RECLAIMING (EG HEAT WHEEL RECOVERY) DEVICES IN USE ON YOUR HEATING SYSTEM: YES ☐ NO ☐
5. IS THERE A HEAT PUMP (PROVIDING BOTH HEATING AND COOLING) ASSOCIATED WITH YOUR HEATING SYSTEM? YES ☐ NO ☐

C. WHAT TYPE OF AIR CONDITIONING IS AVAILABLE IN YOUR BUILDING

1. VENTILATION FANS INDIVIDUAL ☐ CENTRAL ☐ NONE ☐

2. CENTRAL AIR CONDITIONING(COOLING) YES ☐ NO ☐

IF YES, CHECK FUEL USED ELECTRIC ☐ GAS ☐

3. SEPARATE AIR CONDITIONERS IN EACH SUITE YES ☐ NO ☐

IF YES PLEASE ESTIMATE THE PERCENTAGE OF SUITES USING ONE OR MORE AIR CONDITIONING _____ %

D. PLEASE DESCRIBE THE FAUCET WATER HEATING SYSTEM FOR YOUR BUILDING

1. FAUCET WATER HEATING FUEL
ELECTRIC ☐ GAS ☐ HEAVY OIL ☐ LIGHT OIL ☐ OTHER(DESCRIBE) ☐

IF ELECTRIC, IS THERE A SEPARATE WATER HEATER TANK FOR EACH SUITE YES ☐ NO ☐

E. DOES YOUR BUILDING HAVE A SWIMMING POOL?

1. DOES YOUR BUILDING HAVE A SWIMMING POOL?
INDOOR ☐ OUTDOOR ☐ BOTH IN/OUT ☐ NONE ☐

IF SO, SWIMMING POOL HEATER FUEL IS?
ELECTRIC ☐ GAS ☐ HEAVY OIL ☐ LIGHT OIL ☐ NOT HEATED ☐

2. DOES YOUR BUILDING HAVE A SAUNA? YES ☐ NO ☐

IF YES, SAUNA HEATER FUEL IS?
ELECTRIC ☐ GAS ☐ HEAVY OIL ☐ LIGHT OIL ☐

F. OTHER USES

1. WHAT FUEL DO YOU USE IN YOUR WASTE INCINERATORS?

ELECTRIC ☐ GAS ☐ HEAVY OIL ☐ LIGHT OIL ☐ OTHER ☐ REMOVED ☐

2. FUEL SUPPLIED IN EACH SUITE FOR COOKING ELECTRIC ☐ GAS ☐

3. FUEL SUPPLIED TO THE LAUNDRY ROOM FOR CLOTHES DRYING ELECTRIC ☐ GAS ☐

4. IF INDOOR PARKING IS AVAILABLE IN YOUR BUILDING,

ARE THE PARKING SPACES HEATED? YES ☐ NO ☐
ARE THE ENTRY/EXIT RAMPS HEATED? YES ☐ NO ☐

IF EITHER ARE HEATED, WHAT FUEL(S) ARE USED?
ELECTRIC ☐ GAS ☐ HEAVY OIL ☐ LIGHT OIL ☐

TO BE FILLED IN ONLY IF APARTMENT BUILDING HAS BEEN
CONVERTED FROM INDIVIDUAL TO BULK METERING

1. YEAR CONVERTED TO BULK METERING 19____

2. ARE THE INDIVIDUAL METERS STILL IN PLACE? YES ☐ NO ☐

3. HAVE THERE BEEN RENOVATIONS TO THE SUITES OR COMMON AREAS
SINCE THE CONVERSION TO BULK METERING? YES ☐ NO ☐ DON'T KNOW ☐

IF SO, WHAT WAS DONE? _____

4. HAS THE AVERAGE OCCUPANCY RATE CHANGED SINCE THE CONVERSION TO BULK METERING?
YES NO DON'T KNOW

IF YES, FROM _____% BEFORE CONVERSION, TO _____% AFTER CONVERSION?

PLEASE RETURN COMPLETED FORMS BY FEBRUARY 15th

- newly completed buildings;
- mixed commercial-residential complexes;
- government assisted buildings;
- condominiums and co-operatives; and
- oil space heated buildings.

The selection process eliminated 653 apartment buildings. Consumption information for the remaining 1,628 apartment buildings was obtained during the second phase of data gathering. Additional forms were forwarded to those utilities concerned and completed as outlined in Exhibit A1.2. Consumption data was received for a total of 1,327 apartment buildings.

The last phase during the data gathering process involved an examination of the consumption records. In several cases unusual readings were discovered. To ensure data compatibility, the appropriate utilities were contacted and requested to check the consumption data for possible inaccuracies, as outlined in Exhibit A1.3. The final sample used for analysis consisted of 48,632 suites and 1,111 apartment buildings.

Exhibit A1.2

ASSOCIATION OF MUNICIPAL ELECTRICAL UTILITIES
(OF ONTARIO)



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AREA CODE 416

April 13, 1977

TO: Member Utilities

In January of 1977 the Joint Ontario Municipal Electric Association, Association of Municipal Electrical Utilities, Ontario Hydro Study Team investigating electric metering of multiple unit dwellings requested assistance in obtaining data. Your utility and 140 other municipal utilities replied for an overall response of 46% to provide data on more than 2,500 buildings.

This letter is to request your assistance again by providing additional information on the buildings in the attached list.

The new information desired should be inserted on the attached form and returned to this office by May 13, 1977. The building number is the 8 digit number preceding the address of each building in the attached list. If your utility submits bills on a monthly basis, please complete the data requested for each month. If the billing period is other than monthly, please provide the consumption data on the appropriate month line. For those buildings where a conversion in metering practice has been affected, a special report form has been included.

In the refining of data on special facilities, it may be found necessary to request similar data on additional buildings at some future date.

Yours truly,

W.R. Mathieson,
General Manager

attach.

THIS FORM IS FOR BULK METERED BUILDINGS

Building No. _____ (8 digits from 1st line of each address)

Do Not Include "Commercial Establishment" Consumption Data.

<u>MONTH (1976)</u>	<u>KWh</u> <u>CONSUMPTION</u>	<u>PEAK</u> <u>DEMAND</u>
January		
February		
March		
April		
May		
June		
July		
August		
September		
October		
November		
December		

THIS FORM IS FOR INDIVIDUALLY METERED BUILDINGS

Building No. _____ (8 digits from 1st line of each address)

Do Not Include "Commercial Establishment" Consumption Data.

<u>MONTH (1976)</u>	<u>KWh</u> <u>CONSUMPTION</u> *House Suites	<u>PEAK</u> <u>DEMAND</u>
January		
Febrary		
March		
April		
May		
June		
July		
August		
September		
October		
November		
December		

* "House" Consumption Is Defined as "Non-Suite Electricity Consumption in an Apartment Building (ie Halls, Elevators, Parking Areas)".

The following report form is to be used for reporting information on buildings which have been converted from individual suite metering to bulk metering or vice versa.

The objective is to obtain energy consumption for one year prior to changeover and annual consumption data for up to three years following changeover.

Some groups have suggested that the change in metering practice is accompanied by an immediate change in the energy consumption pattern, whereas other groups suggest that the change in consumption is gradual. We are seeking data to indicate what pattern does prevail following a changeover.

THIS FORM IS FOR BUILDINGS WHOSE
METERING SYSTEM HAS BEEN CONVERTED

Building No _____ (8 digits from 1st line of each address)

Do Not Include "Commercial Establishment" Consumption Data.

YEAR BEFORE CONVERSION	19	KWh <u>CONSUMPTION</u>
YEARS FOLLOWING CONVERSION.....	19	
	19	
	19	
	1976	

Exhibit A1.3

ASSOCIATION OF MUNICIPAL ELECTRICAL UTILITIES
(OF ONTARIO)



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AREA CODE 416

June 30, 1977

TO: Member Utilities

SURVEY OF MULTIPLE UNIT DWELLINGS

Attached hereto is a tabulation of apartment buildings on which you have reported building data and electrical energy consumption data.

The electrical energy consumption data varies considerably from other buildings with the same space heating and water heating types. It may be that our records are incorrect on one of the following:

- (a) number of suites
- (b) energy consumption
- (c) type of heating.

Will you please check the data on these buildings and call Mr. Roger A. Crawford in Ontario Hydro at (416) 592-3686 to ensure that this information can be utilized in the Bulk Metering Study.

Yours truly,

H.A. Hopkins, P. Eng.
Engineer

attach.

SURVEY OF MULTIPLE UNIT DWELLINGS

Followup Newsletter re above was mailed to following member utilities:

York	Tweed
London	Warkworth
Etobicoke	Chatsworth
Chatham	Thunder Bay
Ottawa	Sudbury
Grimsby	Bracebridge
Whitby	Cobourg
Scarborough	Bancroft
Lindsay	Sudbury
Fergus	Kitchener
Orillia	Goderich
Smith Falls	Ridgetown
Stouffville	Hamilton
North York	Tottenham
Cobourg	Oshawa
Grand Bend	Niagara Falls
Parry Sound	Amherstburg
Exeter	Mississauga
Dryden	Strathroy
Milverton	Stratford
Beamsville	Owen Sound
Guelph	Galt
Thorold	Woodstock
Aylmer	Hamilton
Belleville	Listowel
Peterborough	Kingsville
	Lucan
	Gananoque

TOTAL MEMBER UTILITIES-54

Prior to subjecting the data to further statistical analysis, electrical consumption levels in electrically heated apartments were adjusted to take into account degree day differences within the sample. It was assumed that approximately one half of the total consumption in each apartment building could be attributed to space heating. The average degree days used to weather correct these levels are summarized by Ontario Hydro Regions in Table A1.1. Since the consumption data pertaining to most of the apartment buildings in the sample was based on 1976 billing records further adjustment was unnecessary.

In order to determine the extent to which electrical consumption differences existed between bulk and individually metered apartments within the sample, a variety of techniques were employed. These are discussed below.

One of the statistical techniques employed was multiple regression analysis. A comparison of the electrical consumption levels between bulk and individually metered apartments by type of fuel indicated significant differences on a per suite basis. The increased electrical energy consumptions in bulk metered buildings amounted to 3,432 kilowatt hours and 1,084 kilowatt hours in all electric and gas heated buildings, respectively.

It was well recognized, however, that consumption differences could have been accounted for by a number of influencing characteristics such as number of suites, age of building, degree of insulation, income of tenants and so on. In all likelihood, only a portion of the actual energy

TABLE A1.1

AVERAGE DEGREE DAYS BY ONTARIO HYDRO REGIONS

<u>Ontario Hydro Regions</u>	<u>Average Degree Days</u>
Central	7,177
Eastern	8,342
Western	7,217
Georgian Bay	8,213
Niagara	7,110
Northeastern	10,055
Northwestern	10,805

Source: Load Analysis Department, Ontario Hydro

differences could be attributed to the form of metering practice. To determine what portion could be attributed to the bulk meter, it was necessary to take into account the influence of as many other factors as data availability would allow.

Questionnaire design and response permitted quantification of twenty five factors other than the metering practice which could have influenced consumption. These variables are listed in Table AI.2.

A linear relationship was assumed between the independent variables listed in Table AI.2 and the dependent variable (kilowatt hour differences) and the multiple regression technique was applied. Certain characteristics were insignificant to consumption because of cross-correlation with other characteristics while others had very little or no effect on consumption. Accordingly, these variables were excluded from further analysis. The remaining independent variables, shown in Table AI.3, were then used in the final regression run which controlled for these characteristics and at the same time introduced the variable "Bulk" to the regression equation. The coefficient of the "Bulk" variable was interpreted as the amount of kilowatt hour consumption attributable to bulk metering. The major findings are summarized in Table AI.4.

An analysis of variance was also applied to matched sub-samples. In order to ensure comparability within the sub-sample, a selection from the total sample of I,III buildings was made excluding the following energy uses:

TABLE A1.2

VARIABLE LISTING

1. Heating Fuel
2. Type of Heating System
3. Thermostatic Control
4. Heat Reclamation
5. Heat Pump
6. Air Conditioning %
7. Air Conditioning Fuel
8. Ventilation System
9. Water Heating Fuel
10. Individual Suite Water Heaters
11. Swimming Pool
12. Swimming Pool Fuel
13. Sauna
14. Sauna Fuel
15. Incineration Fuel
16. Clothes Drying Fuel
17. Cooking Fuel
18. Ramp Fuel
19. Number of Suites by Number of Bedrooms
20. Ownership
21. Type of Metering
22. KWh Consumption
23. Location
24. Number of Floors
25. Number of Elevators

TABLE A1.3
SIGNIFICANT INDEPENDENT VARIABLES

Gas Heated

All Electric

Sauna

Number of Suites

Swimming Pool

Electric Ramp or Plug-In Heaters

Electric Ramp or Plug-in Heaters

Air Conditioning

Number of Suites

TABLE A1.4
MULTIPLE REGRESSION RESULTS

<u>Characteristics</u>	<u>All Electric</u>	<u>Gas Heated</u>
Bulk Metering Effect (KWh/Suite)	2,870	657
Other Effects (KWh/Suite)	562	427
Total Differences (KWh/Suite)	3,432	1,084
F - Ratio	68.1	16.5
Value of F At .005 Probability	5.3	3.1
Significant	Yes-Very	Yes-Very
Coefficient of Determination (R ²)	0.24	0.22
Adjusted R ²	0.24	0.21

- . central air-conditioning;
- . heat recovery systems;
- . electric saunas;
- . electric swimming pool heaters;
- . electric incinerators;
- . electrically-heated garages or ramp heaters;

and .electric water heating in nonelectrically
heated buildings.

This left matched sub-sample by type of metering that had the following electric applications:

	<u>Gas Space Heating</u>	<u>Electric Space Heating</u>
	- 299 cases -	- 387 cases -
Water Heating	gas	electric
Cooking	electric	electric
Laundry	electric	electric
Refrigeration	electric	electric

Within the gas and electrically heated samples, age of dwelling, number of suites, and percentage of air-conditioned suites were controlled for in the analysis of variance program producing the results below by type of fuel.

	Adjusted Annual kWh/Suite		
	Unadjusted Annual	Difference, Controlling	Significance
	<u>kWh/Suite Difference</u>	<u>For Independent Variables</u>	<u>of F</u>
Bulk-Metered Electrically-Heated	+ 3028	+ 2690	.001
Bulk-Metered Gas-Heated	+ 802	+ 536	.054

Annual consumption levels were also examined in apartment buildings converted from bulk to individual metering. These included 36 buildings heated by natural gas and 10 buildings heated by oil. Average annual kilowatt hour differences before and after conversion were compared directly without adjusting for possible load growth. It was found that, on average, annual kilowatt hours decreased by 676 kilowatt hours on a per suite basis.

A2.0 APARTMENT BUILDING FORECAST

For the purpose of the present study, it was necessary to estimate both the number of new apartment suites and the corresponding number of apartment buildings in Ontario up to and including the year 2001. Essentially, this information serves as the bases upon which all other benefit and cost components are derived.

An historic distribution of total housing stock by type of dwelling unit was developed and projected into the future. These projections were based on the following anticipated trend:*

- a relatively strong growth in total housing requirements over the next five years because of a continuing increase in family household formation. It is anticipated that housing requirements will total about 440,000, or about 88,000 per annum;
- a moderation in total household formation after 1980 is anticipated. By 1991, annual housing requirements are expected to decline to about 55,000 per annum. After 1996, annual housing requirements are expected to witness a moderate increase to about 60,000 per annum;
- a continued but slow growth of total multiples to a saturation point of about 45 percent of the market by the early 1990's;
- a decline in apartment units as a percentage of total multiples throughout the period, particularly in the mid to late 1980's. As the current labour force ages, workers will likely achieve higher income levels and in turn, move away from apartments and into home ownership;
- a continued growth of row housing development as a percentage of total multiples throughout the period to reflect the movement away from rental accommodation and into home ownership; and

* Based on: Ontario Housing Requirements 1976-2001, Peter Barnard Association (1977) and Economic Division, Ontario Hydro

- . a continued growth of condominiums as opposed to non-condominiums again to reflect the assumption that ownership is preferred to renting as average family incomes increase.

The estimated number of apartment suites over the period of analysis as well as the total number of corresponding buildings are shown in Table A2.1. Column (1) shows the anticipated annual increase in the total housing stock while column (2) shows the number of new multiple dwelling units. The expected annual increase in apartment suites and buildings are shown in columns (3) and (4), respectively.

An estimate was made for the proportion of total new apartment dwelling units in Ontario which would be electrically heated, gas heated and oil heated for the forecast horizon. Based upon historical data obtained from Statistics Canada* it was assumed that 50 percent would be gas heated and 35 percent would be electrically heated. The remaining 15 percent are expected to be oil heated.

The last two columns in Table A2.1 served as the bases for determining the number of customers residing in either bulk or individually metered apartment buildings throughout the forecast period. In particular, the last column in Table A2.1 which identifies the number of new apartment buildings in a given year was also interpreted as showing the number of bulk metered customers for the same year.

* Statistics Canada, Household Facilities and Equipment Cat No 64-202.

TABLE A2.1

ESTIMATED NUMBER OF NEW MULTIPLE
DWELLING UNITS AND APARTMENT BUILDINGS
COMPLETED IN YEAR SHOWN²
- 1976 - 2001 -

Year	(1) Total Housing Stock	(2) Total Multiple	(3) Apartment Suites ²	(4) Apartment ₂ Buildings ²
1976	91,079	52,430	26,010	325
1977	85,500	26,894	21,450	268
1978	85,500	36,854	21,450	268
1979	85,500	45,871	21,450	268
1980	91,050	45,605	22,770	285
1981	89,460	45,262	22,365	280
1982	89,460	42,356	19,102	239
1983	86,860	40,344	15,799	197
1984	81,900	31,387	11,757	147
1985	81,900	30,176	11,349	142
1985	67,520	19,731	11,051	138
1987	65,280	25,851	10,311	129
1988	63,040	23,597	11,431	143
1989	63,040	30,995	11,304	141
1990	61,120	37,935	14,547	182
1991	54,270	31,417	16,793	210
1992	52,380	30,302	16,449	206
1993	54,270	23,879	13,025	163
1994	54,270	23,879	13,025	163
1994	54,270	23,879	13,025	163
1995	54,270	23,878	13,024	163
1996	60,000	26,400	14,400	180
1997	61,000	26,840	14,640	183
1998	59,000	25,960	14,160	177
1999	60,000	26,400	14,400	180
2000	60,000	26,400	14,400	180
2001	90,090	39,640	21,622	270

Notes: 1. Detail may not add due to rounding.
2. Located in buildings of six-units or more.

Source: Economics Division, Ontario Hydro.

In order to determine the number of individually metered customers throughout the forecast period an estimate of the vacancy rate was required. Table A2.2 shows the estimated vacancy rate for Ontario over the next 25 years. Adjusting the anticipated number of apartment suites for these vacancies gives the classification of individually metered customers who reside in gas heated and electrically heated apartment buildings, as shown in Table A2.3. As can be seen in the table, three categories are identified. Column (1) identifies the existing customers and column (2) shows the number of new customers each year. The last column in Table A2.3 is merely the sum of columns (1) and (2) and identifies the total number of customers for any given year of the study period.

TABLE A2.2
VACANCY AND OCCUPANCY RATES
IN ONTARIO 1977 - 2001

Year	(1) Vacancy Rate %	(2) Occupancy Rate %
1977	2.2	97.8
1978	2.0	98.0
1979	2.3	97.7
1980	2.4	97.6
1981	2.2	97.8
1982	2.2	97.8
1983	2.2	97.8
1984	2.2	97.8
1985	2.2	97.8
1986	2.3	97.7
1987	2.5	97.5
1988	2.7	97.3
1989	3.0	97.0
1990	3.1	96.9
1991	3.0	97.0
1992	2.7	97.3
1993	2.7	97.3
1994	2.8	97.2
1995	2.7	97.3
1996	2.7	97.3
1997	2.6	97.4
1998	2.6	97.4
1999	2.6	97.4
2000	2.6	97.4
2001	2.7	97.3

Source: Economics Division,
Ontario Hydro.

TABLE A2.3

CLASSIFICATION OF INDIVIDUALLY METERED CUSTOMERS
IN YEAR SHOWN 1977 - 2001

Year	(1) Existing Customers	(2) New Customers	(3) Total Number Of Customers
1977	xxxxxx	17,832	17,832
1978	17,869	17,868	35,737
1979	35,628	17,813	53,441
1980	53,387	18,890	72,277
1981	72,426	18,592	91,018
1982	91,019	15,879	106,898
1983	106,899	13,134	120,033
1984	120,032	9,774	129,806
1985	129,806	9,435	139,241
1986	139,099	9,178	148,277
1987	147,972	8,546	156,518
1988	156,192	9,455	165,647
1989	165,141	9,320	174,461
1990	174,281	11,982	186,263
1991	186,465	13,847	200,312
1992	200,921	13,605	214,526
1993	214,527	10,772	225,299
1994	225,068	10,762	235,830
1995	236,074	10,772	246,846
1996	246,835	11,910	258,745
1997	259,020	12,121	271,141
1998	271,141	11,723	282,864
1999	282,864	11,922	294,786
2000	294,786	11,922	306,708
2001	306,394	17,882	324,276

Note:

1. Detail may not add due to rounding.

A3.0 TANGIBLE COSTS

A3.1 ESCALATION RATES

Before discussing the derivation of the various cost components, it should be noted at this point that all future dollars are adjusted to reflect anticipated levels of wages and prices in the economy. Accordingly, all cash flows occurring beyond 1977 are valued in nominal, as opposed to real or constant dollars.

Escalation resulting from changes in productivity (such as a shorter work week, increased vacation allowance, improved work methods, and so on), in contributions made on behalf of employees (such as a larger share of pension costs), or in rates of pay for premium time, is not included in any of the labour forecasts.

Anticipated escalation rates applicable to the tangible cost components are summarized in Tables A3.1 and A3.2 for labour and materials, respectively. In general, wage rates tend to increase at a faster rate than material prices. Hence, the long term (1986-2001) annual average percentage change for labour wages is shown as two percentage points above that for material prices. Varying rates are utilized over the short term period, 1977 to 1985.

TABLE A3.1

LABOUR ESCALATION RATES IN YEAR SHOWN
(ANNUAL AVERAGE PERCENTAGE CHANGE)
1967-2001

Year ¹	(1) Contracting Labour	(2) Other Labour
1967a	8.6	9.0
1968a	6.3	9.0
1969a	11.5	9.5
1970a	17.5	6.5
1971a	12.7	8.0
1972a	11.7	8.0
1973a	7.8	8.5
1974a	11.3	17.0
1975a	12.2	11.7
1976a	12.0	8.5
1977	11.0	7.7
1978	9.5	7.4
1979	9.0	10.0
1980	9.5	9.5
1981	9.5	9.0
1982	8.0	8.0
1983	7.0	7.0
1984	6.5	7.5
1984	7.0	8.5
1986-2001	7.0	7.0

Note: 1. 'a' indicates actual change.

Source: Economics Division, Ontario Hydro.

TABLE A3.2

MATERIAL ESCALATION RATES IN YEAR SHOWN
(ANNUAL AVERAGE PERCENTAGE CHANGE)
1967-2001

Year	(1) Contracting Materials	(2) Stationary Materials	(3) Other Materials
1967a	2.8	1.0	2.3
1968a	-2.9	0.6	-2.5
1969a	3.3	0.3	1.5
1970a	9.2	0.1	6.2
1971a	-2.0	1.1	3.4
1972a	-1.1	0.3	1.9
1973a	11.0	6.0	1.9
1974a	25.3	22.1	20.6
1975a	2.4	14.6	19.2
1976a	1.6	4.2	-0.5
1977	3.5	1.0	3.0
1978	5.0	3.0	5.0
1979	8.5	5.0	6.0
1980	5.0	8.0	6.0
1981	6.0	9.0	5.0
1982	7.0	7.0	5.0
1983	6.0	6.0	3.0
1984	5.0	5.0	4.0
1985	5.0	5.0	5.0
1986-2001	5.0	5.0	5.0

Note: 1. "a" indicates actual.

Source: Economics Division, Ontario Hydro.

A3.2 ELECTRICAL CONTRACTING

A move to individual metering undoubtedly results in additional wiring requirements for all new apartment suites. To obtain dollar estimates of the additional wiring requirements a number of contracting firms involved in this field were contacted. The investigation revealed that:

- for a new individually metered apartment building with fossil fuel heating, the increased cost per suite would be in the range of \$70 to \$150, or an average of about \$120;
- for a new individually metered apartment building with electric heating, the increased cost per suite would be in the range of \$100 to \$200, or an average of \$150;
- for an existing bulk metered apartment building with fossil fuel heating, the electrical costs of converting to individual metering would be about \$1,000 per suite; and
- for an existing bulk metered apartment building with electric heating, the electrical costs of converting to individual metering would be about \$2,000 per suite.

Accordingly, the increased cost for individual metering in a new fossil fuel heated apartment building and in a new electrically heated apartment building were assumed to be in the order of \$120 and \$150 per

suite, respectively. These estimates served as the bases for the anticipated contracting costs. A weighted escalation index - 40 per cent labour and 60 per cent material - was applied.

A3.3 INSTALLATION

In the case of individual metering, it was well recognized that separate meters would be necessary for the domestic and common portion of the apartment building load. On the other hand, only one meter would be installed in an apartment building under the bulk metering policy option.

Installation costs for individual metering were assumed to be about \$78 and \$841 for the domestic and common portion of the apartment building load. The suite metering cost estimate includes the meter, government seal and labour while the common metering includes the same components plus additional expenditures for materials such as the test block and instrument transformers. Installation costs for bulk metering were assumed to be in the neighbourhood of \$971. The higher installation cost for bulk metering is intended to reflect additional expenditures for instrument transformers.

A3.4 ADMINISTRATION (OMA)

This cost category is intended to reflect the additional reading, billing and collecting requirements of individual metering as well as the additional testing and recalibration involved. Table A3.3 shows a detailed account of the additional reading, billing and collecting requirements for

TABLE A3.3

PRESENT WORTH OF INDIVIDUAL ADMINISTRATIVE
COST IN 1977 THOUSANDS OF DOLLARS¹
1977-2001

Year	New Customers		Existing Customers		(5) Total
	(1) New New Accounts	(2) Reading Billing Collecting	(3) Turnover	(4) Reading Billing Collecting	
1977	37.4	62.1	---	---	99.5
1978	34.9	57.9	10.5	115.8	219.1
1979	33.4	55.3	20.0	221.2	329.9
1980	33.7	55.8	28.5	315.4	433.4
1981	31.5	52.2	36.8	406.6	527.0
1982	25.2	41.8	43.3	478.6	588.8
1983	19.4	32.2	47.4	523.9	622.9
1984	13.5	22.4	49.8	549.7	635.4
1985	12.3	20.4	50.8	561.3	644.8
1986	11.1	18.4	50.5	558.1	638.2
1987	9.7	16.0	50.2	554.6	630.4
1988	9.9	16.5	49.3	544.6	620.3
1989	9.1	15.1	48.4	535.2	607.8
1990	11.0	18.1	47.8	527.9	604.8
1991	11.7	19.4	47.2	521.5	599.8
1992	10.7	17.8	47.5	524.6	600.6
1993	7.9	13.1	47.3	522.4	590.7
1994	7.3	12.2	46.0	508.4	573.9
1995	6.9	11.4	45.1	497.8	561.0
1996	7.0	11.6	43.5	481.0	543.2
1997	6.6	11.0	42.6	470.7	530.9
1998	6.0	9.9	41.5	458.1	515.4
1999	5.6	9.4	40.2	443.8	498.9
2000	5.2	8.7	38.9	430.0	482.9
2001	7.2	11.9	36.8	406.8	462.6
TOTAL	374.3	620.3	1,010.0	11,157.9	13,162.5

Note:

1. Detail may not add due to rounding.

four designated categories of individually metered customers. Columns (1) and (2) of this table reflect administrative costs for new customers only, while columns (3) and (4) show the recurring expenses for existing customers.

The estimates shown in column (1) of Table A3.3 take into account the clerical work of receiving applications, opening the account, and credit rating checks. On a per account basis, it was assumed that these costs would amount to about \$2.10 in 1977 dollars. The annual cost of reading, billing and collecting was estimated in 1977 dollars to be about \$6.96 per annum for each customer. This estimate includes the cost of data processing, postage and stationary, receiving payments, meter reading (six readings a year) and arrears. The annual reading billing and collecting costs associated with new customers are shown in column (2) of Table A3.3.

The cost estimates shown in column (3) of Table A3.3 are intended to take into account additional expenses incurred as the result of individually metered customers changing their residency status. These estimates are based upon a thirty per cent turnover rate for existing customers. It was further assumed that the associated cost would amount to about \$2.10 per customer move; in other words, an amount equivalent to the cost of opening a new account.

Reading, billing and collecting costs for existing customers are shown in column (4) of the same table. Again, these estimates are based on the initial annual cost of \$6.96 in 1977 dollars and escalated accordingly. Finally, the total administrative cost associated with individual metering for any given year is shown in column (5) and represents the sum of the previous four columns.

A3.5 TESTING AND RECALIBRATION

To the extent that bulk meters are required for the common service portion of the apartment building load regardless of the metering practice, testing and recalibration cost estimates are only considered for the individual meters.

It was assumed that a statistical sampling procedure would be employed by all supply authorities in Ontario throughout the period of analysis. When a statistical sampling procedure is employed, a sample of newly installed meters must be inspected after eight years usage and every two years thereafter. The nominal sample size in any given year must be in accordance with government regulations.

The actual number of meters selected for the sample in each year of the study period is shown in column (I) of Table A3.4. It should be noted that with a seal extension period of eight years, the first sample drawn does not take place until the year 1984. At this time, about 250 meters are drawn and transported to one location for testing purposes. Similarly, in 1985, an additional 250 meters are sampled. By the year 1986, however, a proportionately higher number of meters are sampled. This takes into account the government regulation which stipulates that after the initial test for a new groups of meters is completed, a recurring sample for the same group of meters must be drawn every other year.

TABLE A3.4
SUMMARY OF INDIVIDUAL TESTING AND RECALIBRATION¹
- 1977-2001 -

Year	(1) Number of Meters Tested	(2) Number of New Meters	(3) Present Worth ² -1977 Dollars-
1977	---	---	---
1978	---	---	---
1979	---	---	---
1980	---	---	---
1981	---	---	---
1982	---	---	---
1983	---	---	---
1984	250	250	11,841
1985	250	---	984
1986	500	250	10,036
1987	500	---	1,706
1988	750	250	9,245
1989	750	---	2,212
1990	950	200	7,226
1991	950	---	2,418
1992	1150	200	6,563
1993	1100	---	2,438
1994	1300	200	5,864
1995	1300	---	2,495
1996	1500	200	5,306
1997	1500	---	2,481
1998	1700	200	4,825
1999	1700	---	2,427
2000	1900	200	4,361
2001	1900	---	2,296
TOTAL			84,724

Notes:

1. Detail may not add due to rounding.
2. Based on a 15 per cent nominal discount rate.

Column (2) of the same table is intended to identify the number of new meters that must be acquired in order to conduct the sample testing. That is, for any year that meters are removed from service and tested, an equal number of meters must be installed for the duration of the test period. The annual cost associated with the testing procedure is shown in column (3) of Table A3.4. The cost figure used for testing purposes amounts to \$5.92 in 1977 dollars per meter tested. It includes the cost associated with transporting and handling the meter. The estimate, however, excludes recalibration costs. It was assumed that given the reliability of conventional individual meters, all samples drawn would more than likely conform with the requirements of the test applied in each period.

Since this cost category only amounted to \$85 thousand over the entire study period, it was included with the administrative cost category in the main body of the report.

A3.6 TERMINAL VALUES

To the extent that an asset purchased at the beginning of the study period has an economic life beyond the final year of the study period it is necessary to include a value for this asset in the final year of analysis. In other words, a meter installed in 1977 which is expected to last 30 years has 7 years of service remaining beyond the period of analysis. Hence, to evaluate a given policy option - be it bulk or individual - a dollar value for the remaining life of the meter must be calculated and included as a retained asset in the final year of analysis. This dollar figure is typically referred to as a terminal value and/or replacement value.

It should be noted that in the context of the present report, terminal values are assigned in the following manner:

$$\text{terminal value} = \text{replacement cost} \times \frac{\text{service life remaining}}{\text{total service life}}$$

On the cost side, terminal values were computed for installation and electrical contracting costs.

A4.0 TANGIBLE BENEFITS

A move to individual metering yields energy savings associated with the fuel and variable operation and maintenance expenses incurred by the generating authority that provides energy. To translate the physical energy savings into dollar estimates, system values of energy differences were obtained from the System Planning Division of Ontario Hydro. These estimates are shown in column (1) of Table A4.1.

Essentially, these figures are based on fuel cost estimates prepared by the Fuels Division in March, 1977 and include full escalation. Moreover, residual oil, US coal, Western Canadian coal, and uranium prices were used in varying proportions to arrive at these values. These estimates are "composite" in that they are derived under the assumption of a 16 hour day and an 8 hour night. Furthermore, to the extent that these estimates are exclusive of transmission and distribution losses they may be regarded as "unadjusted" composite values. The values shown in column (2) of the same table show the adjusted estimates, based on a system loss factor of 6.26 per cent.

In addition to energy savings, a move to individual metering will yield capacity savings associated with building and maintaining a system with sufficient capacity to meet all electrical demands placed on it. Given that energy differences are realized throughout the forecast period it is necessary to ascertain the extent to which these differences affect system expansion.

TABLE A4.1

SYSTEM VALUES OF ENERGY DIFFERENCES
ESCALATED ANNUAL COSTS IN YEAR SHOWN
1977-2001

- MILLS PER KILOWATT HOUR -

Year	(1) Unadjusted Composite Value	(2) Adjusted Composite Value
1977	11.477	12.243
1978	12.852	13.371
1979	13.369	14.262
1980	13.688	14.602
1981	15.312	16.335
1982	15.882	16.943
1983	18.317	19.540
1984	20.605	21.981
1985	23.175	24.723
1986	24.437	26.069
1987	25.612	27.322
1988	26.849	28.642
1989	28.138	30.017
1990	29.490	31.459
1991	30.495	32.531
1992	31.533	33.639
1993	32.587	34.760
1994	33.669	35.917
1995	34.767	37.089
1996	36.079	38.488
1997	37.435	39.935
1998	38.835	41.428
1999	40.269	42.958
2000	41.748	44.536
2001	43.012	45.884

To facilitate the estimating procedure, it is assumed that capacity differences are realized if and only if consumption differences occur at the time of the system December peak load. Moreover, to determine the amount of energy differences occurring at the peak in any given year, the following relationships are utilized:

$$kW = \frac{kWh}{LF_c \cdot t} \quad (1)$$

$$LF_c = \frac{\bar{C}}{C_s} \quad (2)$$

where,

kW = kilowatts demanded at the time of system peak

kWh = kilowatt hours consumed in a given year

LF_c = annual coincident load factor

t = time period of analysis in hours (8760)

\bar{C} = average apartment suite consumption (kWh)

C_s = apartment suite consumption at the time of the system peak

The expression in (1) is used to translate energy differences measured in kWh's to capacity differences measured in kW's. Only one variable on the right-hand side in expression (1) is unknown - the proportion of energy differences which is consumed at the system peak or the coincident load factor (LF_c) for the average apartment building load in Ontario.

Load data on apartment buildings indicated the coincident load factor for apartment suites ranged from 0.3 to 0.5 and 1.13 for the electric heating load and domestic load, respectively.* For the purpose of this report, 0.4 and 1.13 are assumed to be the relevant coincident load factors.

A summary of the estimated capacity differences for gas heated buildings and all electric buildings are presented in columns (1) and (2), respectively, of Table A4.2.

Dollar estimates for the capacity differences were obtained from two sources. The System Planning Division in Ontario Hydro projects system values of peak differences. Their most recent estimates, discounted at 15 per cent to a given starting year, are summarized in columns (2) and (3) of Table A4.3. The capital components (column (2)) are based on cost estimates for a 4 x 750 MW coal fired station and takes into account the cost of the transmission required to incorporate the generation into the bulk power system. The non-capital capacity cost estimates shown in column (3) are intended to represent the fixed maintenance cost of new plants.

The values shown in column (1) of Table A4.3 are intended to represent the transmission and distribution cost consequences of a change in capacity for any given year. These values are also based on estimates obtained from System Planning Division in Ontario Hydro.

* Power Market Analysis, Ontario Hydro.

TABLE A4.2
SUMMARY OF CAPACITY DIFFERENCES
1977-2001
- KILOWATT -

Year	(1) Gas Heated	(2) All Electric	(3) Total
1977	348	3,007	3,355
1978	699	6,033	6,732
1979	693	5,980	6,673
1980	715	6,172	6,887
1981	738	6,371	7,109
1982	674	5,812	6,486
1983	566	4,893	5,459
1984	448	3,864	4,312
1985	375	3,238	3,613
1986	358	3,091	3,449
1987	334	2,886	3,220
1988	340	2,927	3,267
1989	347	2,994	3,341
1990	409	3,531	3,341
1991	512	4,429	4,491
1992	561	4,829	5,390
1993	475	4,111	4,586
1994	413	3,553	3,966
1995	430	3,714	4,144
1996	442	3,816	4,258
1997	479	4,150	4,629
1998	468	4,021	4,489
1999	462	3,987	4,449
2000	465	4,021	4,486
2001	570	4,920	5,490
TOTAL:	12,321	106,350	118,671

Note:

1. Detail may not add due to rounding.

TABLE A4.3

PRESENT WORTH OF PEAK DIFFERENCES
IN DOLLARS PER KILOWATT¹
1977-2001

	(1)	(2)	(3)	(4)
Year	Transmission & Distribution	Generation (Capital)	Generation (Non Capital)	Total Capacity
1977	244	205	32	481
1978	264	235	37	536
1979	289	269	42	600
1980	313	310	48	671
1981	335	357	56	748
1982	357	413	65	834
1983	377	472	74	923
1984	398	541	85	1,024
1985	419	624	97	1,140
1986	437	644	102	1,183
1987	454	666	104	1,224
1988	470	682	197	1,259
1989	486	695	109	1,290
1990	499	704	110	1,313
1991	510	709	111	1,330
1992	517	709	111	1,337
1993	521	701	110	1,332
1994	518	686	107	1,311
1995	509	661	103	1,273
1996	490	624	98	1,212
1997	459	574	89	1,122
1998	413	508	79	1,000
1999	350	419	66	835
2000	264	308	48	620
2001	140	171	27	347

Note:

1. Detail may not add due to rounding.

For any given year, the total value attributable to capacity savings are shown in the last column of Table A4.3. It should be noted that all capacity estimates are based on the November 1976 Escalation Forecast prepared by the Economics Division. Moreover, the estimates as shown in this table are expressed in dollars per kilowatt discounted to the starting year, with the assumption that the kilowatt change in that year is constant throughout the study period. A kilowatt change in 1977, for example, lasting for 25 years is valued at \$481. This represents the present worth in 1977 of one kilowatt which will exist from 1977 to 2001, inclusive. A kilowatt change in 1995, however, only lasts 7 years and is valued at \$1,273 present valued in 1995 dollars. Hence, the present worth in 1977 dollars of a kilowatt change starting in 1995 and lasting till 2001 is equivalent to \$1,273 times the appropriate discount factor.

